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THE QUARTERLY REVIEW of BIOLOGY

VARIATIONS IN THE POTENCY OF THYROTROPHIC HORMONE OF THE PITUITARY IN ANIMALS

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INTRODUCTION

IT IS generally agreed that a separate hormone, a thyrotrophin, produced by the pars anterior of the vertebrate pituitary controls the activity of the thyroid gland and that its production is in turn controlled largely by the thyroid hormone (see reviews of Collip, 1935, 1940; VanDyke, 1936, 1939; White, 1944. [Throughout this review, thyrotrophin will be discussed as a single hormone that influences the activity of the thyroid gland. It has been suggested by Smith (1931) that there may be a thyroid-inhibiting hormone as well as a thyroid-stimulating one produced by the pars anterior; by Heyl and Laqueur (1934) that there may be two thyroid-stimulating hormones, one controlling changes in thyroid weight and the other changes in the histological features of the thyroid. However neither of these suggestions has been proved.] This concept has been built up over the years since a relationship between the two glands was indicated by the enlargement of the pituitary after thyroidectomy (Rogowitsch, 1889). It is based mainly on 1) the demonstration of the dependence of the thyroid for its development and function on the pars anterior in experiments using hypophysectomized amphibian larvae (Adler, 1914; Allen, 1916 and ff.; Smith, 1916 and ff.; see reviews by Allen, 1929a, 1938), and the proof of a similar dependence in mammals (Smith, 1927, 1930, 1931); and 2) the evidence that the anterior pituitary has the capacity to stimulate the thyroid of the normal animal to hyperactivity or to restore that of the hypophysectomized one to normal or greater than normal activity (Smith and Smith, 1922; Smith, 1927, 1930, 1931; Uhlenhuth and Schwartzbach, 1926, 1927, 1928; Aron, 1929, 1930a, b, e, etc.; Loeb and Bassett, 1929, 1930). Although the existence of the thyrotrophic hormone has been established, up to the present the attempts to purify it have not been wholly successful. In a recent paper by White (1944), the methods used since 1931 for extraction and purification are described in some detail. In common with other hormones of the pars anterior, this one is apparently a protein and possibly a pseudoglobulin (Cameron, 1945). White gives a recent analysis of a fairly purified beef thyrotrophin which indicates a composition of 45.67 per cent carbon, 6.09 per cent hydrogen, 12.62 per cent nitrogen, 1.13 per cent sulfur, and 3.52 per cent carbohydrate. The yield of this particular extract was 350–400 mg. per kg. of fresh pituitary tissue, its minimum effective dose 1.0 microgram and its estimated molecular weight 10,000. A less purified sheep thyrotrophin yielded 500–600 mg. per kg. of fresh pituitary tissue, its minimum effective dose was 0.5 microgram, and its estimated molecular weight 35,000; but its composition was not given.

METHODS OF DEMONSTRATING THE PRESENCE OF THYROTROPHIN

The presence of a thyroid-stimulating principle in the pituitary has usually been determined by implanting fresh pituitary (whole or pars anterior)

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or injecting extracts of fresh or desiccated whole or anterior pituitary substance from an animal of one species into another animal of the same or a different species. One or more days after the treatment, the thyroids of the recipient are examined to see whether they have changed, or whether reactions which can be interpreted as due to the release of the thyroid hormone can be observed. A positive response of the thyroid is an increase in its weight or histological signs of hyperactivity, such as an increase in numbers of mitoses, a heightened follicular epithelium, vacuolation and loss of colloid, or a decrease of its iodine content compared with controls. Reactions that are indirect, in that the induced release of the thyroid hormone is responsible for them, but which are nevertheless positive indications of an effect upon the thyroid, include an increase in basal metabolic rate, an increase in blood iodine, a decrease of liver glycogen, an acceleration of amphibian metamorphosis, or an induction of molting in hypophysectomized urodeles (Collip, 1940, pp. 2075–2077; Adams, Kuder and Richards, 1932). In general, animals used for such tests were normal or were animals whose thyroids had been inactivated by administration of thyroxine or iodized substances (deFremery, 1935; Güthert, 1940; Griesbach and Purves, 1943b), by a special diet (Paal and Kleine, 1933), by starvation (Stephens, 1940), or by hypophysectomy (Adams, Kuder and Richards, 1932; Hertz and Oastler, 1936; Van Eck, 1938; Foglia, 1940). On the basis of such tests the existence of thyroid-stimulating hormone in the anterior pituitaries of many vertebrates has been demonstrated, often for several species in a single type of host or for one species in a variety of hosts (Table 1). As may be seen from an examination of this table, the guinea pig thyroid has been activated by anterior pituitary substance from eleven mammals, one bird, and two amphibians. Chicks have responded positively to many of the pituitaries listed as inducing a reaction in the guinea pig. The goldfish thyroid has been stimulated by fish, amphibian, bird, and mammalian pituitary substance. Frog (*Rana pipiens*) and mouse pituitaries have caused a reaction of the thyroids of mice, guinea pigs, chicks, and newts. Stimulation of the amphibian thyroid has occurred after the administration of pituitary substance from the same or other species of amphibians, birds, and mammals. The reptile and fish have rarely been used as donor or host. It is of particular interest that a reaction has occurred even when the pars anterior of a cold-blooded vertebrate has been administered to a warm-blooded one, and vice versa. Such results are an argument against a "zoological specificity" of the thyrotrophic hormone, just as comparable results of tests for gonadotrophins leave such a specificity in doubt for them, though there may be quantitative differences in hormone content in both cases, or proteins carried with the substance may diminish the reaction (Adams, 1939; Adams and Granger, 1941). Cases of "reduced efficiency of administered pituitary hormones from very divergent species" have been described as a "specificità zoologica relativa" by Benazzi (1938, 1940), or as a "relative species-specificity" by Gorbman (1941).

ASSAY METHODS FOR THYROTROPHIN

Although it is possible to demonstrate the presence of thyrotrophin in fresh implants or in extracts of the pars anterior by administering them to a vertebrate host, nevertheless all of the reactions that occur are not equally advantageous for assaying the hormone quantitatively and so providing a basis on which to determine variations in the thyroid-stimulating potency of the gland. Many of the bioassays employed have been presented in some detail by Collip (1940, pp. 2075–2077). Those listed by him are based on the reactions which follow the administration of pituitary substance: 1) the acceleration of axolotl or tadpole metamorphosis; 2) an increased thyroid weight in pigeon, dove, day-old chick, or young guinea pig; 3) histological evidence of thyroid stimulation, evaluated qualitatively or quantitatively, in dove, pigeon, day-old chick, young guinea pig, or hypophysectomized rat; 4) a decrease of thyroid-iodine in chick or guinea pig; 5) a higher basal metabolic rate in normal or hypophysectomized animals. Some additional assay methods have been proposed and others already in use have been modified, with a view to standardizing them more adequately, or have been adapted to other hosts. For example, the tadpole test has been developed to the point where its sponsors, D'Angelo, Gordon, and Charipper (1942) tentatively define "a tadpole unit of thyrotropic activity. . .as the minimal amount of hormone which, when given to the totally starved non-metamorphosing animal in 5 intraperitoneal injections on alternate days, will stimulate the thyroid gland, increase the hind-limb length, and cause a body-weight loss 50 per cent greater than that in water-injected controls"

TABLE 1

Tests of anterior pituitaries showing presence of a thyroid-stimulating hormone

Pituitaries were administered as fresh implants or as extracts of fresh or desiccated substance. Ordinarily only one reference is given for a positive test for each animal listed, although several investigators may have secured such a result.

DONOR	RECIPIENT	AUTHORITY	DONOR	RECIPIENT	AUTHORITY
MAMMALS AS RECIPIENTS* Criteria of response: thyroid activation (weight; histology); increased metabolic rate					
cattle	guinea pig	Aron, 1929	rat	rat	Smith, 1927, 1930
cattle	guinea pig	Loeb & Bassett, 1929	cattle	rat	Anderson & Collip 1933
guinea pig	guinea pig	Loeb, 1932a	toad (*B. arenarum*)	rat	Foglia, 1940, 1941
rabbit	guinea pig	Loeb, 1932a			
cat	guinea pig	Loeb, 1932a	cattle	rabbit	Aron, 1930a
rat	guinea pig	Loeb, 1932b	cattle	mouse	Heyl & Laqueur, 1934
hog	guinea pig	Loeb & Friedman, 1933	cattle	dwarf mouse	Snell, 1930
sheep	guinea pig	Loeb & Friedman, 1933	rat	dwarf mouse	Smith & MacDowell, 1930
man	guinea pig	Kunkel & Loeb, 1935	frog (*R. pipiens*)	immature mouse	Adams & Tukey, 1938
horse	guinea pig	Rowlands, 1936	sheep	ground squirrel	Zalesky, 1935
dog	guinea pig	Rowlands, 1936	rat	ground squirrel	Zalesky, 1935
mouse	guinea pig	Adams & Allen, 1942a	cattle	dog	Aron, 1930a
chick	guinea pig	Adams & Allen, 1942b	rabbit	puppy	Reichert, 1928
frog (*R. pipiens*)	guinea pig	Adams, Granger & Rhoades, 1938			
toad (*B. arenarum*)	guinea pig	Foglia, 1940, 1941	cattle	cat	Aron, 1930a
BIRDS AS RECIPIENTS Criteria of response: thyroid activation (weight; histology)					
cattle	hen	Noether, 1932	cattle	duck	Schockaert, 1931
cattle	chick embryo	Woodside, 1935	cattle	pigeon	Riddle, 1931
cattle	1-day chick	Smelser, 1937, 1938	cattle	ring dove	Bates et al., 1935
sheep	chickens (3–7 wks. old)	Domm & Van Dyke, 1932	rat	pigeon	Schooley & Riddle, 1938
rat	1-day chick	Turner & Cupps, 1939	pigeon	pigeon	Schooley & Riddle, 1938
rabbit	1-day chick	Bergman & Turner, 1941	sheep	sparrow	Miller, 1938
mouse	1-day chick	Adams & Beeman, 1942	man	sparrow	Witschi & Riley, 1940
man	1-day chick	Cope, 1938a	frog (*R. catesbiana*)	sparrow	Keaty & Stanley, 1940–41
frog (*R. catesbiana*)	1-day chick	Keaty & Stanley, 1940–41			
frog (*R. pipiens*)	1-day chick	Adams & Beeman, 1942	man	canary	Witschi & Riley, 1940
toad (*B. arenarum*)	1-day chick	Foglia, 1940, 1941			

REPTILES AS RECIPIENTS
Criteria of response: thyroid activation (weight; histology); increased metabolism; molting

SNAKES			LIZARDS		
cattle	*Xenodon*	Houssay, 1932	cattle (?)	*Lacerta* 3 sp.	Eggert, 1936b
cattle (?)	*Tropidonatus*	Mason, 1938	sheep	*Anolis*	Evans, 1935
sheep	*Thamnophis* 2 sp.	Hellbaum, 1936	**TURTLES**		
snake	*Thamnophis* 2 sp.	Schaefer, 1933	cattle	*Chrysemys*	Evans & Hegre, 1940

TABLE 1—*Continued*

DONOR	RECIPIENT	AUTHORITY	DONOR	RECIPIENT	AUTHORITY
AMPHIBIANS AS RECIPIENTS					
Criteria of response: thyroid activation (histology); metamorphosis; molting					
	larvae	ANURANS		adults	
cattle	*R. boylei*	Smith & Smith, 1923a	"surubi" (fish)	*Bufo arenarum*	Magdalena, 1932
cattle	*R. catesbiana*	Krichesky, 1934	*B. arenarum*	*Bufo arenarum*	Magdalena, 1932
R. catesbiana	*R. catesbiana*	Swingle, 1921	*Xenopus*	*Bufo arenarum*	Houssay, 1943
R. clamitans	*R. catesbiana*	Swingle, 1921	hen	*Bufo arenarum*	Magdalena, 1932
R. pipiens	*R. catesbiana*	Swingle, 1921	rat	*Bufo arenarum*	Magdalena, 1932
R. clamitans	*R. clamitans*	Ingram, 1929	cattle	*Bufo arenarum*	Houssay, 1932
Necturus	*R. clamitans*	Charipper & Corey, 1930	*Xenopus*	*Dendrophryniscus*	Houssay, 1943
cattle	*R. pipiens*	D'Angelo et al., 1942	cattle (?) ("Pretiron")	*R. esculenta*	Lánczos & Áts, 1941
rat	*R. pipiens*	Gordon et al., 1945			
turkey	*R.* (sp. ?)	Riley et al., 1937			
B. halophilus	*B. halophilus*	Allen, 1929b			
R. catesbiana	*B. halophilus*	Allen, 1929b			
Hyla regilla	*H. regilla*	Allen, 1929b			
	larvae	URODELES		adults	
R. clamitans	axolotl	Swingle, 1922	*Triturus viridescens*	*T. viridescens*	Adams, Kuder, & Richards, 1932
cattle (?)	axolotl	Spaul, 1924	*R. pipiens*	*T. viridescens*	Dawson & Jimenez, 1933
cattle (?)	*A. tigrinum*	Uhlenhuth & Schwartzbach, 1926	adult fowl	*T. viridescens*	Stein, 1934
"frogs" (several sp.)	*A. jeffersonianum*	Grant, 1931	chicks (1–10 days old)	*T. viridescens*	Stein, 1934
R. pipiens	*Necturus*	Grant, 1930	mouse	*T. viridescens*	DeForest, 1939 (unpub.)
T. carnifex	*T. carnifex*	Klatt, 1931, 1933	cattle	*T. viridescens*	Adams, 1934
T. alpestris	*T. alpestris*	Klatt, 1931, 1933	sheep	*T. viridescens*	Adams, 1934
T. taeniatus	*T. taeniatus*	Klatt, 1931, 1933	*R. pipiens*	*T. cristatus*	Adams, 1933
T. alpestris	*T. taeniatus*	Klatt, 1931, 1932	*R. vulgaris*	*T. cristatus*	Adams, 1933
			cattle	*T. cristatus*	Adams, 1933
			cattle	*T. torosus*	Uhlenhuth et al., 1939
FISH AS RECIPIENTS					
Criteria of response: thyroid activation (histology)					
sole	goldfish	Gorbman, 1940	sheep	goldfish	Gorbman, 1940
R. pipiens	goldfish	Gorbman, 1940	cattle (?)	goldfish	Gorbman, 1940
R. catesbiana	goldfish	Gorbman, 1940	cattle (?)	eel	Uhlenhuth, 1938
chicken	goldfish	Gorbman, 1940	sheep	*Fundulus*	Abramowitz & Fevold, 1937

* The whale pituitary has been reported to contain thyrotrophin but the assay animal is not given (Geiling, 1937).

(p. 225). They use fifteen *Rana pipiens* larvae for each test and have found that the response will occur "to approximately 1/60 to 1/120 the amount of hormone which can be detected histologically in the guinea pig." Several other investigators have utilized the microhistometric method, developed by Starr, Rawson and their co-workers (Starr and Rawson, 1937; Rawson and Starr, 1938; Starr *et al.*, 1939; Rawson and Salter, 1940), in which the basis for the assay is the increase in thyroid epithelial height produced by thyrotrophin, compared with the height in controls. Thus there is the unit of thyrotrophic hormone suggested by Adams and Beeman (1942) "as that contained in an amount of fresh substance which will give a 100 per cent increase in thyroid cell height of five to ten 1-day-old chicks 24 hours after subcutaneous administration in a single dose" (p. 140). This assay has been shown to be sensitive to small amounts of thyrotrophin and requires but a single treatment, with autopsy 24 hours later, compared with the more usual three or four treatments and autopsy on the fourth or fifth day after the first treatment. It might be possible to decrease the length of time after administration of the pituitary substance even more, if the chick thyroid epithelium should prove to respond as quickly as does that of the guinea pig to thyroid-stimulating substance (Krogh and Okkels, 1933a; Kummer, 1938; Starr and Metcoff, 1941). Others have proposed assays measured by the thyroid-cell-height method, but in a different recipient. Gorbman (1940) has found the goldfish thyroid very sensitive to pars anterior substance from fish, amphibians, birds, and mammals; and Galli-Mainini (1943) has used the normal or hypophysectomized male toad (*Bufo arenarum*). Another method suggested is that of Güthert (1940), who has discovered a significant difference in nuclear size in pituitary-treated rats compared with that in untreated animals. However, he points out that the thyroid should be inactivated by prior treatment of the test rats with diiodotyrosine and that the measuring of the nuclei is very time-consuming. One of the newest tests, one that involves a very short treatment but a somewhat elaborate technique, is that of De Robertis and Del Conte (1944). It is based on the fact that intracellular colloid droplets increase quickly in the thyroid epithelium after administration of thyroid-stimulating substance. In order to establish the test, guinea pigs have een injected with various doses of Antuitrin T, the thyroids removed thirty minutes later, frozen in liquid air, dried by the Altmann-Gersch method, sectioned and stained with aniline blue and orange-G. A cytological coefficient has been determined and defined as "the ratio between the number of colloid droplets × 100 and the average diameter of the follicles" (p. 98). A "guinea pig cytological unit" is "the amount of thyrotropic factor which injected in the blood stream of a young guinea pig can quadruplicate in 30 minutes the cytological coefficient of the control animal" (p. 98). This unit is "approximately one thousand times smaller than that of Junkmann-Schoeller." Among all these bioassays the ones still most commonly used are those which employ 1) certain percentage increases over the values in controls of thyroid weight or thyroid cell height of young guinea pigs, chicks, or doves given anterior pituitary substance (Rowlands and Parkes, 1934; Smelser, 1937, 1938; Rawson and Starr, 1938; Bergman and Turner, 1939; Adams and Beeman, 1942) or 2) the qualitative response in the thyroid histology compared with a standardized series of stages (Junkmann and Schoeller, 1932; Heyl and Laqueur, 1934).

COMPARISON OF THYROTROPHIC POTENCY OF PITUITARY IN ANIMALS

From the above survey of methods of assay, it is obvious that it is difficult to compare the thyrotrophic potency of the anterior pituitaries of different animals in which various assays have been used. Furthermore, it is hard to equate the doses, because sometimes implants of fresh substance, and at other times extracts of fresh or desiccated material have been administered. Often, too, the quantities of original tissue from which extracts have been made have not been clearly stated. Nevertheless, since the guinea pig and the chick are the animals most commonly employed for assay and since the same test has often been used for the pituitaries of different animals, it is possible to attempt a comparison of variations in potency in several animals or in one animal at different periods of its existence or under a variety of experimental conditions.

In the early experiments of Aron, Loeb and others, the young guinea pig was utilized as the assay animal because of its relatively inactive thyroid gland, which responded quickly to thyroid-stimulating substances. Correlated with this thyroid inactivity was the fact that the guinea pig's pars anterior was very low in thyrotrophin

(Loeb and Bassett, 1930; Loeb, 1932a, b, c; Emerson, 1937). Similarly the young chick's thyroid presented a picture of very uniform inactivity (Smelser, 1937, 1938; Cope, 1938a), though different breeds or even strains of the same breed may vary somewhat in this respect (Bates, Riddle and Lahr, 1941; Adams and Jensen, 1944). Preliminary tests of the young chick's pars anterior have indicated that it also contains a small quantity of thyrotrophin (Adams and Allen, 1942b). In contrast, rats, mice, and rabbits have proven to be unsatisfactory assay animals because their thyroids are so active that unless the animals are hypophysectomized (Hertz and Oastler, 1936; Van Eck, 1938) or their thyroids inactivated by some other means, such as a thyroid-depressing diet (Paal and Kleine, 1933) or the administration of thyroxine or some iodized substance (De Fremery, 1935; Güthert, 1940; Griesbach and Purves, 1943b), their responses are much less pronounced than those in the guinea pig or chick. Again, however, in correlation with their very active thyroids, the anterior pituitaries of the former animals have been shown to be rich in thyroid-stimulating hormone (Loeb, 1932a, b; Kunkel and Loeb, 1935; Adams and Allen, 1942a; Adams and Beeman, 1942). In fact, it appears that a very active thyroid gland is usually associated in a normal animal with a pars anterior which is high in thyrotrophic content (Aron, 1931; Thurston, 1933; Collip, 1934; Loeb, Saxton and Hayward, 1936).

But in what relative position with regard to thyrotrophic potency can these and other animals be placed? In 1942, Adams and Allen attempted to arrange a series of animals with respect to the thyroid-stimulating capacity of their anterior pituitaries. For this purpose they utilized data which had been secured in their laboratory (Adams and Tukey, 1938; Adams, Granger and Rhoades, 1938) or which had been reported in the literature (see Adams and Allen, 1942a, p. 217 ff.). Their list in order of descending potency ran: "frog [*Rana pipiens*], rat, mouse, dog, pig, cattle (beef), toad (?), sheep, turkey, horse, man, rabbit, cat, pigeon, young chick (?), guinea pig, hen" (p. 221). The pituitaries of all of these animals except the pigeon and turkey had been assayed on guinea pigs, and the pigeon was placed in the list on the basis of its thyroid activity (Thurston, 1933). A reexamination of this list in the light of further data discovered in the literature or obtained from additional experiments leaves it almost unchanged. Loeser (1937) and Chance, Rowlands and Young (1939) would reverse the order of the potency of man and horse but that of rat, pig, ox, and sheep would remain. However, the data reported by White (1944) contradict those of Jorgensen and Wade (1941) and of previous investigators, and indicate that the sheep pituitary yields a higher quantity of thyrotrophin per kg. of fresh tissue and has a lower minimum effective dose than that of beef, facts which would put the former in the lead. Further tests of the potency of the mouse and frog anterior pituitaries by Adams and Beeman (1942) have led to some uncertainty as to the relative position of these animals in the list, for in certain experiments the frog pituitary seemed more potent than that of the mouse and in others the reverse was true, though both are high in content of thyrotrophin. According to Foglia's (1940, 1941) assays on chicks and guinea pigs, the toad (*Bufo arenarum*) would remain in its present position relative to the mouse and the frog, but his data offer no further information with regard to its relation with the other animals in the foregoing list. Also the tests carried out by Gorbman (1940, table 1) on the goldfish allow the insertion of fish (sole) into the list, probably after the frog (*R. pipiens*), of the bull-frog ahead of *R. pipiens*, and of "chicken" (age?) parallel with the leopard frog, but after the bull-frog. The high potency of the bull-frog's pars anterior is also confirmed by the experiments of Keaty and Stanley (1940–41). Thus the revised list would read: bull-frog, leopard frog, chicken (age?), sole, rat, mouse, dog, pig, sheep, toad (?), cattle (beef), turkey, man, horse, rabbit, cat, pigeon, young chick (?), guinea pig, hen.

It is obvious that there is no close correlation of high or low thyrotrophic potency of the pars anterior with the phylogenetic position of the animals in the series. However, the anterior pituitaries of the small number of cold-blooded forms (sole, leopard frog, bull-frog, and toad) for which assays have been attempted appear to contain relatively high quantities of thyrotrophin compared with those in warm-blooded animals. Among the latter, even within closely related groups such as birds or rodents, there is a wide divergence in thyroid-stimulating capacity. Only the ungulates stand fairly close together. It must be emphasized, however, that any list is a tentative one. It must remain so until the assays of all types of pituitaries are either made by a single method and with comparable amounts of fresh

substance or purified extracts and/or compared with a standardized preparation. Such a standard was set up by the Third International Conference on Standardization of Hormones, in 1938. According to this standard, 250 micrograms of a preparation deposited with the National Institute for Medical Research at Hampstead, London, is equivalent to one unit of hormone. It is probable that bioassays will have to be used for a long time, since the protein nature of the thyrotrophic hormone makes it "difficult to visualize an adequate direct chemical method for its quantitative detection," (White, 1944, p. 7).

In summary, it may be stated that marked variations in the thyrotrophic potency of the pars anterior of animals have been demonstrated by assaying the glands. These variations appear to bear no fundamental relation to the phylogenetic position of the animal.

VARIATIONS IN THYROTROPHIN RELATED TO AGE, SEX, AND REPRODUCTIVE ACTIVITY

From the preceding discussion, it is evident that variations exist in the thyrotrophic potency in the different species of animals. What is the situation with regard to variations in a single species with respect to age, sex, and reproductive activity? Here the data should yield more definite conclusions, since it is more likely that assays for one species will have been carried out by the same method and often by the same investigators. Furthermore, some differences in potency might be anticipated because of the often-reported variations in thyroid activity in various animals. The tests for possible differences in potency associated with age and sex have been made upon pituitaries or body fluids (blood and urine) from rats (Turner and Cupps, 1939; Griesbach and Purves, 1943a), rabbits (Ch'en and Van Dyke, 1936; Saxton and Greene, 1939; Bergman and Turner, 1941), guinea pigs (Aron, 1931), mice (Adams and Mothes, 1945), cattle (Bates, Riddle and Lahr, 1935; Reece and Turner, 1937), swine (Elijah, 1940, cited by Bergman and Turner, 1941), and humans (Aron and Klein, 1930; Müller, Eitel and Loeser, 1935; Saxton and Loeb, 1937; Witschi and Riley, 1940). With respect to age, the assays have indicated an increase in potency from prepuberty to puberty, a period of rapid growth, followed by a decrease after sexual maturity has been fully established. [Saxton and Greene (1939) have found that the pituitaries of immature female rabbits (10–70 days old) contain more thyrotrophin than those of young mature ones (4–8 months old), but the latter contain more than those of old females.] This has been true for all except human beings, where only slight or no differences have been found, (Table 2, Fig. 1, reproduced from Adams and Mothes, 1945, Table 3, Fig. 1). With regard to sex, the male pituitary has been reported to be more potent than the female one in the rat (Turner and Cupps, 1939) and cattle; less potent in the male mouse at prepuberty and puberty but more potent at early sexual maturity; while no significant differences in the two sexes were found in rats (Griesbach and Purves, 1943a), rabbits, and human beings (Table 2, Fig. 1). It is interesting that in the mice the changing relationship of thyrotrophic potency in the two sexes is something like the shift that occurs in gonadotrophic potency in the rat, where the male gland is less potent than the female one early in life but is more potent at maturity (Clark, 1935).

Several of the investigators who have tested the thyrotrophic potency of the pars anterior of animals with respect to variations linked with age or sex have included in their work a consideration of possible modifications related to reproductive activity. According to Saxton and Greene (1942), there is a decided decrease of thyrotrophin content of the pars anterior of rabbits 24 and 28 hours after mating, but it is restored to normal by 48 hours post-coitus. They have correlated this reaction with the "rapid and almost complete removal of colloid from the thyroid, with associated swelling of acinar epithelium" (p. 398), described by Krjlow and Sternberg (1932) for female rabbits just after mating.

The pituitaries of pregnant and lactating cattle, albino rats, rabbits, and human beings have been assayed, but the data do not present a wholly consistent picture. In cows, according to Bates, Riddle, and Lahr (1935), the thyrotrophic content of the pituitaries is greatest in early pregnancy and falls during late pregnancy to approximately the amount present in the non-pregnant animal. The data of Reece and Turner (1937) for heifers, 11 to 23 months old, tally with those of Bates *et al.*, since in animals of this age group, pregnant 1–140 days, there is more thyrotrophin per gram of fresh pituitary tissue (42.99 guinea pig units) than in those pregnant 141–283 days (31.98 GPU) or in non-pregnant animals (24.59 GPU). These

investigators have also found a difference in dairy and beef cows during pregnancy and lactation. In both types there is less thyrotrophin in the pituitaries of dry, pregnant animals than in dry, open ones, but more thyrotrophin in lactating, pregnant ones than in lactating, open ones. Likewise, the thyrotrophin is more abundant in lactating, pregnant cows than in dry, pregnant animals. It has been shown, too, that the thyrotrophin content of dairy cow that the values lie within the range for normal females. No differences have been revealed in assays of pituitaries and urine of pregnant and non-pregnant women (Aron and Klein, 1930; Saxton and Loeb, 1937; Witschi and Riley, 1940).

All of the above animals belong in the mammalian group. Very few investigations concerned with the lower vertebrates have been found. One is the report of Keaty and Stanley (1940–41) that in similar doses the pituitaries of the bull-frog

TABLE 2

The thyrotrophic potency of the pituitaries of certain mammals

(AL = anterior lobe; PA = pars anterior)

(From Adams and Mothes, 1945. Table 3. Courtesy of the Wistar Institute.)

	CATTLE Bates et al., '35 (table 1)[1]; % incr. dove thyroid wt. per gm. fresh pit.		CATTLE Reece and Turner, '37 (summary); guinea pig units per gm. fresh AL		RABBITS Bergman and Turner, '41 (table 2); Bergman-Turner chick units per gm. fresh pit.		RATS Turner and Cupps, '39 (table 1); Bergman-Turner chick units per gm. fresh pit.		MICE Adams and Mothes, '45; Adams-Beeman, '42 (p. 140) chick units per gm. fresh PA	
	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
Pre-puberty	calves 148.6		calves 26.4		149 gm. body wt. 30.88	163 gm. body wt. 29.75	75.9 gm. body wt. 141	75.47gm. body wt. 121	26–27 days 295	485
Puberty	?	?	4–10 mos. 38.36	32.13	2503 gm. body wt. 83.92	2489 gm. body wt. 89.00	129 gm. body wt. 332.8	123.6gm. body wt. 208.0	40–41 days 338	503
Early sexual maturity	"Adult bulls" 269.6	"Not pregnant cows" 206.0	11–23 mos. 35.02	24.59	4128 gm. body wt. 53.27	4021 gm. body wt. 48.80	224.7 gm. body wt. 210.0	226.0gm. body wt. 127.0	82–23 days 286	201
Late sexual maturity			2 yrs. or older Dairy 36.03 Beef 22.53				274.9 gm. body wt. 174.0	259.0 gm body wt. 139.0		

[1] Data calculated for 1 gm. fresh pituitary from table 1.

pituitaries is consistently greater than that in beef cow pituitaries. For rats, Turner and Cupps (1939) have reported that the concentration of thyrotrophin in the female albino rat during estrus and the first half of pregnancy is low, but that there is a definite increase during the latter part of pregnancy and a still further increase of 40 per cent during lactation. Tests carried through by Bergman and Turner (1943) on rabbits pregnant for 10, 20, and 28 days and on those 2, 5, 10, 20, and 30 days post-partum have indicated (*Rana catesbeiana*) in the post-breeding season contain twice as much thyrotrophin as do those of animals of the pre-breeding season. This fact seems to link the thyrotrophic potency with reproductive activity. In younger stages of amphibians there are indications of differences in thyrotrophic potency very early in development (Allen, 1932; Etkin, 1938). Allen has shown that the pituitaries of *Bufo halophilus* in the process of metamorphosis or completely metamorphosed will induce metamorphosis in tadpole recipients

with hind legs 1–3 mm. long, while no reaction will occur if the pituitaries used are from donors with hind legs less than 6 mm. long. A similar change in content has been demonstrated when the pituitaries are taken from bull-frog donors in stages corresponding to those of *Bufo* and implanted into *Bufo* tadpoles. Data concerning *sylvatica* as development proceeds from the premetamorphic to post-metamorphic stages, and has induced a more precocious metamorphosis with four implants than with one.

In birds, there are a few items that may be mentioned in connection with the question of thyrotrophic potency as related to age and sex,

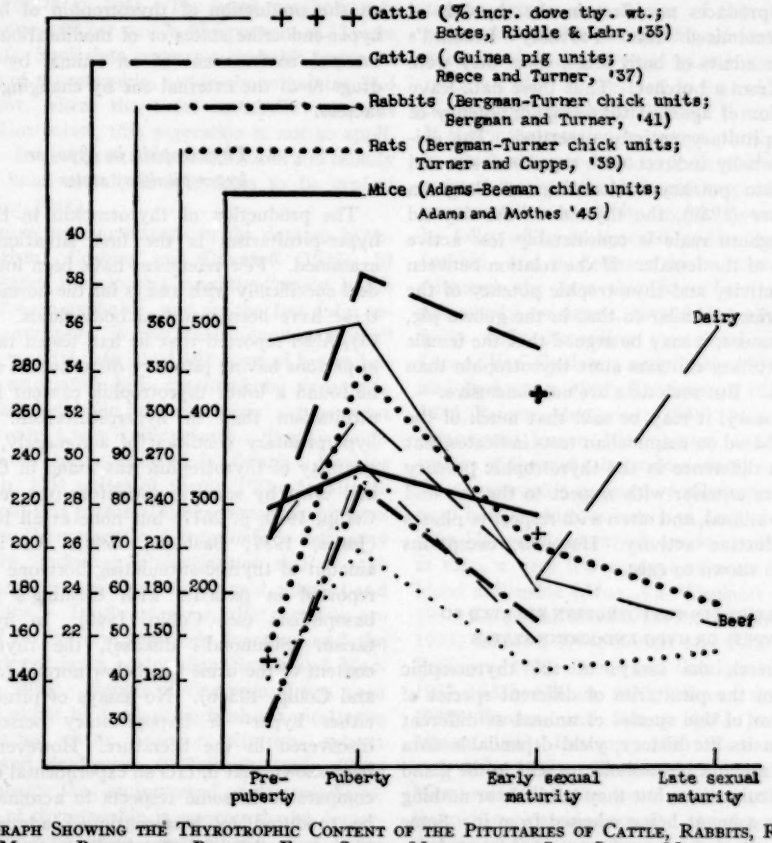
Cattle (% incr. dove thy. wt.; Bates, Riddle & Lahr, '35)
Cattle (Guinea pig units; Reece and Turner, '37)
Rabbits (Bergman-Turner chick units; Bergman and Turner, '41)
Rats (Bergman-Turner chick units; Turner and Cupps, '39)
Mice (Adams-Beeman chick units; Adams and Mothes '45)
Dairy
Beef
Pre-puberty
Puberty
Early sexual maturity
Late sexual maturity

FIG. 1. GRAPH SHOWING THE THYROTROPHIC CONTENT OF THE PITUITARIES OF CATTLE, RABBITS, RATS, AND MICE AT PREPUBERTY, PUBERTY, EARLY SEXUAL MATURITY, AND LATE SEXUAL MATURITY

For data, see table 2. In similar designs, the heavy line represents data for males; light line, data for females. (From Adams and Mothes, 1945. Courtesy of the Wistar Institute.)

actual amounts of substance are not available for comparison, but it may be significant that when Allen (1929b) used the pituitaries from *Hyla regilla* in a somewhat similar series of experiments, two implants from younger tadpoles were not as effective as a single one from an older stage. Etkin also has demonstrated the increasing thyrotrophic potency in pituitaries of *Rana pipiens* and *R.* but they lead to no definite conclusions. A comparison of the data of Gorbman (1940) on the potency of chicken pituitaries (age?) and those of Adams and Allen (1942b) on that of chicks 1–4 days old might be interpreted as indicating that the older (?) bird's pituitary contained more thyrotrophin than the younger one's. However, Domm (1931) has seen no evidence of thyroid

stimulation in male and female Leghorns, 22 to 86 days old, which have been given many homoplastic implants of fresh whole or anterior pituitary from adults. Houssay, Novelli and Sammartino (1932), too, have reported that pituitaries of hens induce slight or no activation of the guinea pig's thyroid; and Leonard (1937) has has found that the administration of chicken hypophyses produces no effect in the thyroids of hypophysectomized rats. Probably Leonard's birds were adults of both sexes, since they were procured from a butcher. Thus these data leave the question of age and thyrotrophic potency of the fowl pituitary entirely unsettled. The evidence is wholly indirect with regard to sex and thyrotrophic potency. According to Bergman and Turner (1939), the thyroid of the day-old White Leghorn male is considerably less active than that of the female. If the relation between thyroid activity and thyrotrophic potency of the pars anterior is similar to that in the guinea pig, rat, and mouse, it may be argued that the female chick's pituitary contains more thyrotrophin than the male's. But such data are not conclusive.

In summary, it may be said that much of the evidence based on mammalian tests indicates that there is a difference in the thyrotrophic potency of the pars anterior with respect to the age and sex of the animal, and often with respect to phases of reproductive activity. However, exceptions have been shown to exist.

VARIATIONS IN THYROTROPHIN RELATED TO HYPER- OR HYPO-ENDOCRINE STATES

In general, the assays of the thyrotrophic potency of the pituitaries of different species of animals, or of one species of animal at different periods in its life history, yield dependable data as to the amount of hormone present in the gland at a particular time, but they tell little or nothing about the amount being released from it. Some hint as to the latter may be expected from observations of the degree of activity of the thyroid gland, the amount of thyrotrophin in the blood or urine, or both. For example, a very active thyroid might be linked with marked release of thyrotrophin and at the same time with an increased or a decreased storage, depending, respectively, on whether the production was very high or just sufficient to take care of the release. Conversely, an inactive thyroid might be interpreted as due to a diminished release and at the same time associated with heightened storage, if production were continuing, or else with reduced storage, if production were greatly lessened. Helpful evidence on whether storage or release predominates can also be secured from a study of pituitary cytology. If possible, all of these features concerned with the pituitary-thyroid relation should be considered in the interpretation of experiments designed to investigate the effect on the production of thyrotrophin of hypo- or hyper-endocrine states or of modifications of the internal environment of an animal by diet or drugs or of the external one by changing various factors.

A. Thyrotrophin in hypo- or hyper-pituitary states

The production of thyrotrophin in hypo- or hyper-pituitarism is the first situation to be examined. Few references have been found that deal specifically with assays for the hormone, and these have been made on body fluids. In 1930 (d), Aron reported that he had tested the urines of persons having pituitary disturbances and that he found a lower thyrotrophin content in hypopituitarism than in hyperpituitarism. In the hyperpituitary condition of acromegaly, a large quantity of thyrotrophin was found in the blood and urine by some investigators (see references, Collip, 1940, p. 2077) but none at all by others (Jones, 1939; Bastenie, 1940). An increased amount of thyroid-stimulating hormone was also reported in patients with Cushing's pituitary basophilism (see Collip, 1940). In hypopituitarism (Simmond's disease), the thyrotrophin content of the urine was below normal (Anderson and Collip, 1934b). No assays of pituitaries of either hyper- or hypopituitary persons were discovered in the literature. However, it has been shown that in rats an experimental condition comparable in some respects to acromegaly can be produced by long-continued administration of thyrotrophin and that it eliminates the thyrotrophin of the recipients' pituitaries so completely that negative results are secured when they are assayed for thyrotrophin (Anderson and Collip, 1934a; Collip and Anderson, 1935). In animals so treated, the cytological appearance of the pituitary is markedly changed (Collip, Selye, and Thomson, 1934; Severinghaus and Thompson, 1939).

In human hyperpituitarism and hypopituitarism, even those data concerning the thyroids and the basal metabolic rate, which might have

an indirect bearing on the question of the amount of thyrotrophin being released, are not entirely consistent. In acromegalics, Cushing and Davidoff (1927a, b) have reported that "acromegaly is often accompanied by an adenomatous and enlarged thyroid; but whether actual exophthalmic goiter may co-exist is a question of doubt, even though examples have been described in the literature" (1927a, p. 104). The basal metabolic rate was above +10 per cent in 45.6 per cent of 72 cases studied. Such data suggest a probable increased release of thyrotrophin, but in the remaining 54.4 per cent, where the basal metabolic rate was normal or below, this suggestion is not so applicable. In giants, an abnormal thyroid and usually a low basal metabolic rate seem to be typical (Hoskins, 1941).

There is more agreement in the data on hypopituitarism. Cushing and Davidoff (1927a, b) have stated that in this condition"rarely is the thyroid even palpable, and in the few fully recorded autopsies it has been found atrophic" (1927a, p. 104). In 71 of 107 cases of hypopituitarism associated with chromophobe adenomas, the basal metabolic rate was below −1 per cent and in only 4 was it above zero. Similar conditions seem to be present in dwarfs. Hoskins (1941, p. 171) writes of them: "The basal rate is reduced and presumably the metabolic pictures are those characteristic of anterior-lobe deficiency generally, including abnormalities due to the secondary depressions of the thyroid, adrenal and sex glands." In dwarf mice, the thyroids are reduced in size and relatively inactive, and the pars anterior lacks acidophiles (Smith and MacDowell, 1930). Repair of the thyroid has been brought about by implanting fresh rat pituitaries or injecting cattle anterior pituitary extract (Smith and MacDowell, 1930; Snell, 1930). Thus it is probable that an increased or decreased production of thyrotrophin is associated with hyper- and hypo-pituitarism, respectively, but more data concerning these conditions are needed.

B. Thyrotrophin in hypo- or hyper-thyroid states

With regard to the effect of hyper- and hypothyroidism on the thyrotrophic potency of pituitaries and body fluids more data are available. Presumably in the vertebrates a delicately balanced relationship is maintained between the amounts of thyroid hormone produced and stored or released by the thyroid, and of thyrotrophin produced and stored or released by the pars anterior of the pituitary (Aron, 1930c; Loeb, Bassett, and Friedman, 1930; Houssay, Biasotti, and Magdalena, 1932; Van Eck, 1939; Uotila, 1940b; Galli-Mainini, 1941; Rawson, Sterne, and Aub, 1942; Rawson, Graham, and Riddell, 1943). According to the observations of these and many other investigators, the thyroid hormone inhibits the production and release of thyrotrophin and may even inhibit the making of further thyroid hormone by the thyroid gland itself. Thyrotrophin's rôle, in contrast, is that of a stimulant to the production and release of thyroid hormone. If this interpretation is correct, then experiments in which a hyper- or a hypo-thyroid condition is created in the animal should support it, since a pronounced increase in thyroid hormone should be followed by a lessened production of thyrotrophin, and a decrease by a heightened one. Although the data that have been secured are not wholly consistent, they fit the above pattern fairly well. According to several investigators (Aron, Van Caulaert, and Stahl, 1931; Hohlweg and Junkmann, 1933; Kuschinsky, 1933; Franck, 1936; Reforzo-Membrives, 1938, 1940, 1942, 1943; Adams and Jensen, 1944; Jensen, 1945), administration of thyroid substances reduces or eliminates the thyrotrophic potency of pituitaries, of urine, or of both, in rats, guinea pigs, and mice (and the thyroids become inactive); and in hyperthyroidism in man, a very low content or none is found in blood and urine (Aron, Van Caulaert and Stahl, 1931; Krogh and Okkels, 1933b; Smith and Moore, 1933; Giedosz, 1934; Bodart and Fellinger, 1936; Fellinger, 1936; Hertz and Oastler, 1936; Cope, 1937, 1938b; Spence, 1937; Emerson and Cutting, 1938; Rawson and Starr, 1938; Jones, 1939; Means, 1939; Bastenie, 1940; Rawson, Sterne, and Aub, 1942). The experiments of Reforzo-Membrives on rats even suggest that hyperthyroidism may induce the development of a thyroid-inhibiting factor as well as eliminate the thyroid-stimulating one. In hypothyroid conditions, a greater content of thyrotrophin in pituitaries and body fluids of thyroidectomized dogs, rats, rabbits, and of myxedematous and thyroidectomized human beings has been reported by some investigators (Aron, Van Caulaert and Stahl, 1931; Giedosz, 1934; Ch'en and Van Dyke, 1934, 1936—for female rabbits; Bodart and Fellinger, 1936; Fellinger, 1936; Hertz and Oastler, 1936; Zeckwer, 1936b; Thompson, 1937; Emerson and Cutting, 1938; Rawson and Starr, 1938;

Means, 1939; Starr *et al.*, 1939; Bastenie, 1940; Turner and Cupps, 1940—for female rats; Rawson, Sterne, and Aub, 1942; Griesbach and Purves, 1943a—in serum; Gordon, Goldsmith, and Charipper, 1945). Others have found no increase of thyrotrophin in thyroidectomized rats and goats and in cases of human myxedema (Houssay, Novelli, and Sammartino, 1932; Hohlweg and Junkmann, 1933; Spence, 1937; Cope, 1938b; Reforzo-Membrives, 1938; Reineke, Bergman, and Turner, 1941; Severinghaus, 1942); and still others have observed even less than the normal amount in the pituitary (Lebedewa, 1936; Turner and Cupps, 1940—for male rats; Griesbach and Purves, 1943a).

The rather consistent decrease of thyrotrophin in pituitaries and body fluids of hyperthyroid animals and human beings seems to indicate its diminished production, storage, and release, especially if the hyperthyroidism has been created by administering thyroid hormone. There is also the likelihood that in human hyperthyroidism (some cases of Graves' disease and toxic goiter) the pituitary produces a greater than normal amount of thyrotrophin (Thompson and Thompson, 1944) but that this is quickly neutralized by the hyperactive thyroid gland. Experiments in which both hormones have been used simultaneously or the effects of each contrasted *in vivo* or *in vitro* can be so interpreted (Aron, 1930c; Canzanelli and Rapport, 1938; Van Eck, 1939; Seidlin, 1940; Belasco and Murlin, 1941; Galli-Mainini, 1941; Rawson, Sterne, and Aub, 1942; Rawson, Graham, and Riddell, 1943). In the work of Rawson, Graham, and Riddell, slices of thyroids from patients with Graves' disease, observed in tissue cultures to which thyrotrophic hormone had been added, inactivated twice as much thyrotrophin as those from normal persons; while goitrous tissue (non-toxic nodular goiters) inactivated none. Thus the role of the thyroid hormone is upheld both as an inhibitor of the production of thyrotrophin and as an inactivator of it after release.

Conversely, many of the results secured in the experiments on hypothyroidism support the idea that when the thyroid hormone is reduced or eliminated, the production of thyrotrophin is no longer inhibited, and its manufacture and release increase. Its storage appears to be less consistently affected. Some recent work on rats, using the goitrogenic action of thiourea and sulfadiazine (Gordon, Goldsmith, and Charipper, 1945; Griesbach and Purves, 1945) or of a rape seed diet (Griesbach and Purves, 1943a; Purves, 1943) or total or subtotal thyroidectomy (Griesbach and Purves 1943a, 1945; Gordon *et al.*, 1945) to create a hypothyroid condition, brings out certain of the difficulties in the interpretation of the pituitary activity. All the foregoing methods produce a lowered level of thyroid hormone, since the goitrogenic diets and drugs prevent its synthesis and thyroidectomy removes its source wholly or in part, depending on the completeness of the operation. It is agreed by these investigators that more thyrotrophin is produced and released by the pars anterior in the thyroidectomized rat, and so the serum has a higher content. However, one group (Griesbach *et al.*,) claims that the thyrotrophin content of the pituitary is lowered, and the other (Gordon *et al.*) that it is increased. Since Griesbach's rats had been thyroidectomized for only 60 days and Gordon's for six months, it may be that the length of the post-thyroidectomy period is involved in the different results. Both groups of investigators report that with the goitrogenic diets or drugs the thyrotrophic potency of the pituitary is decreased due to a heightened release, but one group (Griesbach *et al.*) finds in the serum a higher, and the other (Gordon *et al.*) a lower, content than normal. Gordon and his co-workers believe that the thyrotrophin is removed and utilized by the hyperplastic thyroid. The fact that rats, thyroidectomized after having first been made goitrogenic by feeding them thiourea for 20 days, have an increased amount of thyrotrophin in their serum makes this explanation plausible. It is possible, too, that the hyperplastic thyroid of a rat fed on the rape seed diet differs in some way from that of one given thiourea, though they seem very similar. Or the difference in the methods of assay may be involved—Gordon uses tadpoles; Griesbach, hypophysectomized rats. However, in spite of these discrepancies in data and interpretation, it is evident that the lowered thyroxine level is the primary factor in increasing the thyrotrophin production. This is further borne out by the fact that the slight reduction in thyrotrophic content of the pituitary and the changes in the cytological characteristics of the pituitary that follow subtotal thyroidectomy can be rectified by administering small doses of thyroxine (Griesbach and Purves, 1943a, 1945). It is interesting that the experiments with subtotal thyroidectomy have led Griesbach and

Purves (1945) to sponsor the basophile cell as the producer of thyrotrophin.

C. *Thyrotrophin in hypo- and hyper-gonadal states*

While evidence for a pituitary-thyroid and a pituitary-gonad relationship is established beyond doubt, and the existence of a direct relationship between the thyroid and the gonads seems possible, the latter may be an indirect one, mediated by the pars anterior. As was shown earlier (p. 7 ff.), some data indicate that there are differences in thyrotrophic potency of the pituitaries of the two sexes in some animals and, for females, variations related to phases of reproductive activity. It has also been stated many times that hyper- and hypo-thyroid states may be associated with disturbances in reproduction (possibly via modification of gonadotrophin production by the pars anterior) and that hyper- and hypo-gonadal conditions may be linked with changes in thyroid structure and function (possibly via modification of thyrotrophin production) (Lerman, 1941; Severinghaus, 1942). Thus when the thyroid is found to be more active than normal in castrated guinea pigs (Aron and Benoit, 1931; Loeser, 1934; Kippen and Loeb, 1936) or less active in castrated mice, rats, and immature guinea pigs (Benazzi, 1929; Andersen and Kennedy, 1933; Ross, 1938; Bomskov and Schneider, 1939), it is natural to think that changes in the production and release of thyrotrophin may have occurred. This is true also when treatment with sex hormones induces greater or less thyroid activity (depending somewhat on the length of treatment) in normal dogs and normal or castrated rats and mice (Kunde, D'Amour, Gustavson, and Carlson, 1930; Benazzi, 1933; Leiby, 1933; Pincus and Werthesson, 1933; Amilibia, Mendizábal, and Botella-Llusiá, 1936; Franck, 1937; Nathanson, Brues, and Rawson, 1940). On the other hand, if the thyroid remains normal after castration or administration of gonadal hormones (Chouke, 1930; Aron and Benoit, 1932; Shumacker and Lamont, 1935; Starr and Bruner, 1935; Uotila, 1940a), it is equally natural to assume no modification of thyrotrophin production by the pars anterior.

Again the markedly similar, though not identical behavior of the basophile cells of the pars anterior in both castrated and thyroidectomized animals (Zeckwer, 1936a; Severinghaus, 1937a, b, 1939; Reese, Koneff, and Wainman, 1943) suggests that the production of thyroid-stimulating substance may have been modified by the operations. This is plausible since it is known that the basophilia after castration is associated with increased production and storage of gonadotrophins and since it is probable, though not entirely proven, that it is allied with increased production and release (or storage ?) of thyrotrophin (and gonadotrophin ?) after thyroidectomy or in hypothyroid conditions (Severinghaus, 1937b; Griesbach and Purves, 1943a, 1945). [It is probable that thyroidectomy decreases the production of the gonadotrophins, but some investigators have found no change and occasionally an increase has been reported. See Stein and Lisle (1942) for references.] However, the acidophiles, as well as the basophiles, undergo changes in hypo- and hyper-gonadal or -thyroid conditions, and it has not yet been determined with certainty which of the chromophile cells manufactures the thyroid-stimulating substance. Much of the evidence favors the basophile as its source, but some data can be interpreted as supporting the acidophile (Table 3).

Though the foregoing seems to indicate that the production of thyrotrophin has probably been modified after castration or administration of sex hormones, data based on assays of the content of thyrotrophin in the pars anterior or body fluids in these conditions are scanty and somewhat contradictory. Hoskins (1941, p. 146) states that "castration also lowers the thyrotrophic content" of the pituitary. The most convincing support for this statement is found in the work on bulls and steers (Bates, Riddle, and Lahr, 1935; Reece and Turner, 1937) and on castrated rats of both sexes (Turner and Cupps, 1940). Bates *et al.* showed that the thyrotrophic content per gram of pituitary tissue of adult steers was about half that of adult bulls. It was also lower in the two age groups tested by Reece and Turner. At 4–10 months of age, the bull pituitary contained 38.36 guinea pig units (GPU) per gm. of fresh tissue and the steer pituitary, 25.59 GPU; at 11–23 months, 35.02 and 16.30 GPU, respectively. In the rats, Turner and Cupps have reported reductions of 18 per cent in thyrotrophic content for females and 47 per cent for males castrated for 20 days and of 100 and 93 per cent, respectively, after 66 days. Attempts to restore the normal level of thyrotrophin in the castrated males by injections of estrogens or androgens or thyroxine were not successful, while in castrated females

TABLE 3

A summary of certain data concerning the cellular source of thyrotrophin in the pars anterior (PA)

EVIDENCE FOR THE BASOPHILE AS SOURCE OF THYROTROPHIN	
Increase of basophiles is associated with metamorphosis in toads.	Allen *et al.*, 1929
Increase of basophiles is associated with maximum thyroid activity in 3 species of *Rana*.	D'Angelo, 1941
Basophilic cells (types 2 and 3) in sheep pituitary decrease in size and apparent activity a short time before colloid accumulates in thyroids.	Warbritton & McKenzie, 1937
Extracts of basophilic (central) region of bovine PA cause thyroid hyperplasia in hypophysectomized tadpoles; of acidophilic (cortical) region do not.	Smith & Smith, 1923b
The thyrotrophic hormone is found "in greater concentration in extracts of tissue taken from the basophilic central zone, than in the more peripheral and predominantly acidophilic and chromophobic cortical portion of the beef anterior pituitary gland" (p. 43).	Smelser, 1944
"Basophiles increase in size and number and become vacuolated. . . . The acidophiles decrease or disappear" (p. 374) following a) thyroidectomy in mammals of some species in reptiles in amphibians b) goitrogenic rape seed diet in mammals c) administration of goitrogenic drugs (but evidence concerning thyrotrophic content of the PA varies, see text, p. 12).	Severinghaus, 1942 Severinghaus, 1937a, b (Rev.) Severinghaus *et al.*, 1934b Siler, 1934 Grobstein, 1938 Griesbach, 1941 Griesbach & Purves, 1945
Basophiles increase "in numbers and cytological activity" but acidophiles do not change "in numbers or amount of granulation" in mammals subjected to subtotal thyroidectomy; condition is associated with increased secretion of thyrotrophin and prevented by administration of thyroxine.	Griesbach & Purves, 1945
Basophilia in PA of castrated male pigeon is associated with higher content of thyrotrophin.	Schooley, 1937
EVIDENCE FOR THE ACIDOPHILE AS SOURCE OF THYROTROPHIN	
"Oxyphil cells appear to be mainly concerned with metamorphic activity"; judged by effects of extracts of cattle PA.	Spaul & Howes, 1930
Increase in acidophiles in *Triturus viridescens* at metamorphosis from larval to red eft stage, and again at change from land to water residence, is associated with increased thyroid activity.	Copeland, 1943
Lack of acidophiles in PAs of dwarf mice is associated with atrophic thyroids.	Smith & MacDowell, 1930
(a) Increase in acidophiles and their degranulation after coitus in rabbit is (b) associated with sudden decrease in thyrotrophin in PA and (c) activation of thyroid post-coitus.	a) Dawson, 1942 b) Saxton & Greene, 1942 c) Krjlow & Sternberg, 1932
In hyperthyroidism "basophiles are . . . increased in size and vacuolation occurs, but to a more limited extent [than after thyroidectomy]. The acidophiles . . . show increases in size and number, a greater affinity of their granules for plasma stains, and a definite hypertrophy of the Golgi apparatus . . . , an indication of increased secretory activity" (p. 374). (Evidence indicates that thyrotrophic content of PA is decreased, see text p. 11).	Severinghaus, 1942 Severinghaus *et al.*, 1934a Severinghaus, 1937a, b (Rev.)

TABLE 3—*Continued*

EVIDENCE FOR THE ACIDOPHILE AS SOURCE OF THYROTROPHIN—*Continued*

"It seems to me . . . that the acidophilic source is indicated . . . by the hyperthyroidism in cases of acromegaly, and by frequent hyperthyroidism during pregnancy, where we have extremely active acidophilic cells. Hyperthyroidism is also frequently associated with chorio-epitheliomas, where one observes also an increased acidophilic activity" (p. 148).	Severinghaus, 1937b
Desiccated thyroid prevents the loss of or restores the acidophilic granules in pituitaries of thyroidectomized rabbits or those with parenchymatous goiter. "This evidence could be . . . interpreted as indicating that the acidophilic granules contain the thyrotropic factor . . . " (p. 810).	Marine *et al.*, 1935
Increase in acidophiles and decrease of basophiles in PA follows injections of adrenalin or cortical hormones in rats; is associated with increased thyrotrophin in PA.	Jores, 1938b

either sex hormone, but not thyroxine, accomplished this. [Theoretically injections of thyroxine would deplete the thyrotrophic content of the pituitary still further.] On the other hand, Bomskov and Schneider (1939) have observed no diminution but rather a slight increase of thyrotrophin, (though probably within the normal range) for the pituitaries of castrated male and female rats. Some preliminary experiments on castrated mice of both sexes (Pratt, 1943, unpublished; Thompson, 1943, unpublished) have also revealed no significant change in the potency of the pituitaries of males castrated two, three, or four weeks, or of females castrated for one or three weeks, and possibly a slight decrease at four to five weeks. In guinea pigs, Loeser (1934) has demonstrated an increased thyrotrophic potency in the pituitaries of females castrated for 18–19 days, and Aron and Benoit (1931) an increase in the hormone in the serum of castrates of both sexes. They (Benoit and Aron, 1931) have found the latter true also for castrated cocks and drakes. Schooley (1937) has demonstrated an increased thyrotrophic potency, accompanied by marked basophilia, in the pars anterior of castrated male pigeons. The findings on guinea pigs tally with the greater thyroid activity in castrates reported by Aron and Benoit (1931), Loeser (1934), and Kippen and Loeb (1936), but not with the lack of effect or lessened activity described by Chouke (1930) and Ross (1938).

Following administration of sex hormones, a diminution of thyrotrophin in the pars anterior has been found in estrogenized rats (Simpson and Evans, 1941). In earlier experiments by Shumacker and Lamont (1935), the thyroids of theelin-injected rats were normal, which seemed to indicate that the production of thyrotrophin had not been changed. No reports of assays for thyrotrophin after administration of androgens have been discovered except in the experiments of Turner and Cupps (1940), who attempted to maintain normal thyrotrophin production in castrates (see p. 13). However, Nathanson *et al.* (1940) speculate as to whether the thyroid stimulation following injection of testosterone propionate in immature female rats is due to a direct action on the thyroid or is mediated via the pars anterior. Thus many of the data reviewed above suggest that the sex hormones are associated with changes in thyrotrophin production and that the interrelation of the thyroid and the gonads may be handled through the pars anterior.

D. Thyrotrophin in hypo- and hyper-adrenal states

The other endocrine gland that seems likely to have a direct or indirect relation (via the pars anterior) with the thyroid is the adrenal, but little investigation of thyrotrophin production in hyper- or hypo-adrenal states has apparently been attempted. In 1938 (a, b), Jores reported that adrenalectomy decreased the thyrotrophic content of the rat pituitary and that it could be restored to normal by injections of adrenalin but not of Cortidyn (a cortical extract). Either hormone given to normal animals raised the usual thyrotrophic content somewhat. Jores examined the pituitary cells of normals given injections of adrenalin or Cortidyn after short periods (ad-

renalin: 15, 30, 60 minutes; Cortidyn: 4 hours) or longer ones (adrenalin: 10 days; Cortidyn: 8 days), and found a marked reduction in basophiles and an increase in numbers and staining capacity of acidophiles after both treatments. He therefore associated thyrotrophin production with the latter. Jores' results concerning the reduction of basophiles in adrenalectomized rats have been confirmed by Reese, Koneff, and Akimoto (1939), but the latter report a decrease in number and size of the acidophiles also. Although they did not make assays and do not commit themselves as to which type of the chromophile cells manufactures thyrotrophin, they do state that "the concentration and elaboration of [this] hormone [s] in the glands of adrenalectomized animals would doubtless be diminished, since both chromophil types show evidence of diminished function and damage..." (p. 393). Jores (1938b) has cited a paper by Lipprosi published in 1936 in which the latter records no changes in the histological appearance of the hypophyses of white rats injected every other day for 22–54 days with adrenalin or cortical extract. Tests of thyrotrophic potency of the anterior pituitaries of adult male albino mice injected daily for 2, 4, and 6 weeks with adrenalin have been made and compared with tests for controls by Paul (1945, unpublished). The differences in potency were not marked and were of questionable significance. However, in the 6-weeks series, the average thyroid cell height of the adrenalin-injected mice was significantly higher than that of controls, a fact which suggests a possible increase in the release of thyrotrophin from the pars anterior in the former. Perry (1943) has described hyperplastic thyroids in female rats injected with adrenalin, but he is inclined to think that there is a direct action on the thyroid, not mediated by the pars anterior. The weights of the latter are markedly reduced (2–3 mg. compared with 7 mg. in controls), the number of basophiles is decreased, and he implies that the acidophiles are functioning subnormally although he does not describe their cytological condition. Thus it is still an open question whether thyrotrophin production has any relation to the amount of adrenal-medullary or adrenal-cortical hormone in the body.

E. Thyrotrophin and hypo- or hyper-states of islet tissue or parathyroids

The other two endocrines whose experimental modification might possibly be linked with the production of thyrotrophin by the pituitary are the islets of Langerhans and the parathyroids. However, no references to the amounts of thyrotrophin in the pars anterior or the body fluids in hyper- or hypo-states of either of these glands have been found. It seems probable that any relation the thyrotrophin might have with the islet tissue would be mediated via its control of thyroid activity (Haist, 1944). This may be so for the parathyroids as well.

In summary, it may be said that the experimental investigation of hyper- and hypo-endocrine states in relation to thyrotrophin indicates the marked interdependence of pars anterior and thyroid in its production and release. There is a great probability that the gonadal hormones and a possibility that the adrenal hormones also influence somewhat the amounts of thyrotrophin made and released from the pars anterior. Perhaps the gonads and adrenals affect the pituitary indirectly via the thyroid, but that is uncertain (Table 4).

VARIATIONS IN THYROTROPHIN IN RELATION TO DIET, DRUGS, AND TOXINS

Other factors than the changes in the endocrine glands that may modify the internal milieu of animals and bear some relation to the production of thyrotrophin by the pars anterior are dietary modifications and the administration of drugs and toxins. A three weeks' starvation diet has caused no change in weight or histology of the thyroids or in the thyrotrophic potency of the pituitaries of the starved rats compared with normally fed ones (Hundhausen, 1939). However, other investigators have observed a decided inactivity of the thyroids of starved rats and guinea pigs (Mulinos and Pomerantz, 1940; Stephens, 1940; D'Angelo, Gordon, and Charipper, 1941). Furthermore, in starved guinea pigs, the reduction of acidophiles, the enlargement and vacuolation of the basophiles, and the decidedly greater number of chromophobes, and in rats the marked decrease in pituitary size suggest a modification in the production of thyrotrophin. Results vary with regard to vitamin factors in the diet. Drill (1943) has recently reviewed much of the information available concerning the thyrotrophic potency of the pars anterior in relation to lack or excess of vitamins. Referring to the work of Schulze and Hundhausen (1939a), he states that "a lack of vitamin A leads to increased thyroid activity and increased thyro-

TABLE 4

Summary of data concerning variations in thyrotrophic content of pars anterior and of body fluids and in thyroid activity under various conditions.

(B.M.R. = basal metabolic rate)

(See text. It is obvious that some of the data are contradictory.)

CONDITION	THYROTROPHIN IN			THYROID ACTIVITY
	PARS ANTERIOR	BLOOD SERUM	URINE	
HYPER- AND HYPO-ENDOCRINE STATES				
Hyperpituitarism				
Pathological				
Acromegaly		Increase	Increase or none	Increased or ? (Enlarged thyroid) (High, normal, low B.M.R.)
Gigantism				"Abnormal" (low B.M.R.)
Pituitary basophilism		Increase	Increase	
Experimental	None			Increased (Enlarged thyroid)
Hypopituitarism				
Pathological				
Simmond's disease			Decrease	
Chromophobe adenomas				Decreased (Atrophied thyroid; low B.M.R.)
Dwarfism				
Experimental	(PA removed)			Decreased (Atrophied thyroid; low B.M.R.)
Hyperthyroidism				
Pathological				
Graves' disease		Decrease or none	Decrease or none	Increased (Enlarged thyroid; high B.M.R.)
Toxic goiter				
Experimental	Decrease or none or "thyroid-inhibiting factor"		Decrease or none	Decreased
Hypothyroidism				
Pathological				
Myxedema		Increase	Increase	Decreased (Low B.M.R.)
Operative		Increase	Increase	
Experimental	Increase or normal or decrease	Increase	Increase	(Thyroid removed)
		Normal	Normal	(Thyroid removed)
		Increase	?	(Thyroid removed)
Hypergonadism				
Experimental	Decrease or normal			Increased or normal or decreased
Hypogonadism				
Experimental	Decrease			Decreased
	Increase	Increase		Increased
	Normal			Normal
Hyperadrenalism				
Experimental				
+ Adrenalin	Increase			Increased
	Normal			Normal
+ Cortical hormone	Increase			?

TABLE 4—*Continued*

CONDITION	THYROTROPHIN IN			THYROID ACTIVITY
	PARS ANTERIOR	BLOOD SERUM	URINE	
HYPER- AND HYPO-ENDROCRINE STATES—Continued				
Hypoadrenalism				
Total adrenalectomy	Decrease			
INTERNAL FACTORS (Other than hyper- or hypo-endocrine states)				
Starvation	Normal			Normal Decreased
Vitamins + A	Decrease			Decreased
− A	Increase			Increased
− B_1	Decrease			Decreased
− B_2	Normal			Normal
− C	Normal			Increased
− E	Normal			Increased; decreased; normal
Goitrogenic food	Decrease	Increase		Decreased (Enlarged thyroid)
Goitrogenic drugs	Decrease	Decrease		Decreased (Enlarged thyroid)
Diphtheria toxin	Decrease			Decreased
"Infectious diseases"	Increase			
EXTERNAL FACTORS				
Electronarcosis		Increase		Increased
Carbon monoxide	Decrease			Increased
Lowered atmospheric pressure	Normal	Decrease		Decreased
Temperature: Low	Normal			Increased
High	Decrease			Decreased

trophic potency of the pituitary gland, whereas hypervitaminosis has the opposite effect" (p. 361). Extracts of pituitaries of rats deficient in vitamin B_1 for 6 to 7 weeks are reported to have 40 to 50 per cent less thyrotrophin than those from normal animals, and their thyroids contain much colloid and have flat follicular epithelium (Hundhausen and Schulze, 1939). Deficiencies in vitamin B_2 (Schulze and Hundhausen, 1939b), vitamin C (Schulze and Linnemann, 1938), or vitamin E (Bomskov and Schneider, 1939) do not affect the thyrotrophic content of the pituitary. The thyroids of B_2-deficient rats have been described as normal (Schulze and Hundhausen, 1939b), of E-deficient ones as active (Paal and Kleine, 1933) or inactive (Singer, 1936; Bomskov and Schneider, 1939) or unchanged (Telford, Emerson and Evans, 1938), and of C-deficient ones as active (Schulze and Linnemann, 1938). Evidently vitamin C exercises some control on the thyrotrophic hormone, for when given with thyrotrophin the thyroids are less stimulated than when thyrotrophin is given alone (Marine, Baumann, and Rosen, 1934). Nothing was discovered in the literature concerning vitamin D and thyrotrophin.

A study of the thyrotrophin situation in animals given goitrogenic foods (several of the *Brassica* group of vegetables, such as cabbage or rape seed; soy beans, etc.) indicates that the hyperplastic, though hypofunctioning, thyroid gland is being stimulated constantly by an increased production and release of thyroid-activating hormone from the pars anterior. The increase is thought to be brought about by the lowered thyroxine level, since the goitrogenic factor (like the thioureas, see ff.) prevents the synthesis of thyroxine. The

pars anterior shows marked cytological changes (Griesbach, 1941). Though evidently manufacturing thyrotrophin more rapidly, its content is reduced, and the serum content is enlarged because of its speedy release (Kennedy and Purves, 1941; Griesbach and Purves, 1943a; Purves, 1943). In hypophysectomized rats on a rape seed diet, no thyroid response occurs; or if hyperplasia has previously been produced and the animals are then hypophysectomized, it is not maintained (Griesbach, Kennedy and Purves, 1941). The thyroid hyperplasia may also be prevented by the administration of thyroxine or diiodotyrosine (Purves, 1943). Both of these facts indicate the essential involvement of the pars anterior in the production of the goiters. A prolonged diet of rape seed may be associated with adenomata in the thyroid, evidently due to the excessive stimulation by the thyrotrophin. These growths can be induced to store colloid, if thyroxine is administered to suppress the thyrotrophin production (Griesbach, Kennedy, and Purves, 1945).

The administration of drugs such as the thioureas or sulfonamides has also produced goitrogenic changes in the thyroids of animals (rats, rabbits, mice, guinea pigs, dogs, chicks) and a modification of thyrotrophin production (Astwood, Sullivan, Bissell, and Tyslowitz, 1943; Mackenzie and Mackenzie, 1943, 1944; Mixner, Reineke, and Turner, 1944; Williams, Weinglass, Bissell, and Peters, 1944; and others). The mechanism is apparently similar to that accompanying rape seed diet and has been more fully investigated. Evidently there is less thyroid hormone because the synthesis of the thyroxine is upset,—both thyroxine and non-thyroxine iodine are speedily decreased and evidently excreted in the urine (Baumann, Metzger, and Marine, 1944); the thyroids have a decreased capacity to collect iodine (Keston, Goldsmith, Gordon, and Charipper 1944; Larson, Keating, Peacock, and Rawson, 1945a. b; Rawson, Cortell, Peacock, and Means, 1944); and the "enzyme systems of the thyroid which are necessary to the iodination of thyroid protein" are thrown out of gear (Dempsey, 1944; Paschkis, Cantarow, and Rakoff, 1944; Rawson, Evans, Means, Peacock, Lerman, and Cortell, 1944, p. 11). [Although the administration of potassium thiocyanate also induces the formation of goiters, these hyperplastic thyroids can collect even larger amounts of administered radioactive iodine than normal thyroids (Rawson, Hertz, and Means, 1943; Rawson, Cortell, Peacock, and Means, 1944).] This sparsity of thyroxine results in an increased production and release of thyrotrophin, which induces enlargement and hyperplasia in the thyroid and continues to do so over long periods. Owing to these interactions, the thyrotrophic potency of the pars anterior is weakened and that of the serum is decreased because the thyrotrophin is evidently being utilized and removed by the hyperplastic thyroid (Gordon, Goldsmith, and Charipper, 1945). (This would be similar to the removal of thyrotrophin by thyroid tissue of Graves' disease in tissue culture reported by Rawson, Graham, and Riddell in 1943.) The hyperplasia of the thyroid can be reduced by the administration of thyroxine (Astwood *et al.*, 1943; Dempsey and Astwood, 1943; Mackenzie and Mackenzie, 1943; Reineke, Mixner, and Turner, 1945). It will be recalled that with the rape seed diet, the thyrotrophin in the serum is increased; with thiourea it is decreased. Whether there is a real difference here in the reaction to the two substances should be investigated further.

Another experimental procedure that is said to modify the production of thyrotrophin is the injection of diphtheria toxin. In rats and guinea pigs a decrease of 20 to 50 per cent in anterior pituitary thyrotrophin together with an inactive thyroid has been reported (Dieckhoff and Schulze, 1937). It is implied that the inhibition of the pituitary is the primary reaction. If this is true, it differs somewhat from the mechanism supposed to work in goitrogenic diets or drugs where the thyroid reaction presumably occurs first. It is interesting that Müller, Eitel, and Loeser (1935) have clained that a greater than normal content of thyrotrophin is present in pituitaries of human beings succumbing to infectious diseases.

Summary: From the above discussion, it is apparent that some dietary modifications, such as starvation, excess or lack of certain vitamins, and foods containing goitrogenic factors, or the administration of goitrogenic drugs or of toxins, may be associated with a change in the thyrotrophic content of the pars anterior and of the body fluids of animals subjected to these treatments (Table 4).

VARIATIONS IN THYROTROPHIN IN RELATION TO CHANGES IN THE EXTERNAL ENVIRONMENT

Included among the reports on the results of changing external conditions on the thyroid-pituitary relations in animals are those on the effects of electronarcosis, carbon monoxide, lowered

atmospheric pressures, and changes in temperatures. Electonarcosis applied to guinea pigs and dogs results in an increase of thyrotrophin in the serum and of the weights and epithelial cell heights of the thyroids (Ellis and Wiersma, 1945). No assay of pituitary thyrotrophin is given, but it would probably be decreased. Exposure of rats and guinea pigs to carbon monoxide induces hyperplastic thyroids and decreased thyrotrophin in the pars anterior (Kampelmann and Schulze, 1937; Linnemann, 1939). According to Gordon, Tornetta, D'Angelo, and Charipper (1943), rats subjected to low atmospheric pressures (280–250 mm. Hg.) six hours daily ("discontinuous low pressure") or 18–20 hours daily ("continuous low pressure") for 14 to 20 days have less thyrotrophin in their serum, but their pituitary content is normal, and the thyroids are less active. Whether the lowered serum content is due to greater excretion or to a lessened release from the pars anterior is not clear. If the latter were true, a higher thyrotrophic content of the pars anterior might be expected.

The effect of temperature changes on the thyroids of various animals has been known for some time (see Selye, 1936; Bailiff, 1937, for references), and a few attempts have been made to investigate the condition of the pars anterior occurring simultaneously. It is generally agreed that with exposure to very low temperatures, the thyroids of animals are hyperactive (Wolf, 1934; Kuschinsky, 1935; Selye, 1936; Bailiff, 1937; Uotila, 1939a, b, c. 1940c; Dempsey and Uotila, 1940; Starr and Roskelly, 1940; Dempsey and Astwood, 1943; Leblond, Peacock, and Evans, 1943). At higher temperatures, they are inactive (Wolf, 1934; Kuschinsky, 1935; Bailiff, 1937; Dempsey and Astwood, 1943). That these responses are largely controlled by the pars anterior is shown by the facts that the cytological characteristics of the pituitary change markedly (Bailiff, 1938) and that the temperature responses do not occur in hypophysectomized animals exposed to cold (Uotila, 1939b). But the nervous system may also be involved, since bilateral cervical sympathectomy lessens the thyroid reaction slightly, though only temporarily (Uotila, 1939b), and since the response of the thyroids of cold-exposed animals is lacking after pituitary stalk section (Uotila 1939a, c, 1940b, c; Dempsey and Uotila, 1940). In a recent paper Lowe, Ivy, and Brock (1945) report a study of the basal metabolic rate of guinea pigs during exposure to cold (7–14°C.) for 16 days following bilateral cervical sympathectomy. They suggest that the cervical sympathetic nerves normally play a role in inhibiting thyrotrophin production and release, or thyroid hormone production and release, since in the operated animals a higher basal metabolic rate occurred at the ninth day of cold exposure than in the controls.

The pituitaries of rats kept at 4°C. have been assayed after 12–24 hours, 48 hours, 10–12 days, and 25 days of exposure to the low temperature. No significant difference in thyrotrophic content of the pars anterior of such animals and that of normals kept at 13–20°C. was found, except in two individuals of a large series of animals (Kuschinsky, 1935). Nevertheless at the last two autopsy periods the thyroids were more active in the cold-exposed than in the control animals. Starr and Roskelly (1940) have found a rather sudden increase in the thyroid cell height of rats kept in a refrigerator for 14 to 18 days. This was maintained or even increased somewhat, up to 45 days; but at 56 days it dropped, though not to the level of rats at room temperature. Recent work of Leblond, Peacock, and Evans (1943) indicates that correlated with their more active histological appearance, thyroids of rats kept at 0°C. for 1, 3, 7, and 26 days and given injections of radioactive iodine show a significant increase in the iodine fixed at two hours post-injection in the 7 and 26-day cold periods. They also report an increasing turnover and excretion of iodine and more rapid formation of thyroxine in these two groups. In rats exposed to high temperatures (38–40°C.) the pituitary thyrotrophin was decreased after 4–6 days, none could be demonstrated at 14–23 days, but at 26 days a very small amount was present (Kuschinsky, 1935). At 4–26 days the thyroids were inactive, and their follicles contained much colloid and were bounded by flattened epithelium; but thereafter a few glands showed slight activity. Thus in the heat-exposed animals the correlation between pituitary thyrotrophin content and thyroid activity seems to be closer than in those exposed to cold. It is not fully understood how this reaction to temperature takes place, i.e., whether the pars anterior is stimulated directly or by the nervous system. It is even possible that temperature may act directly on the thyroid,—at least that suggestion is made by Turner and Turner (1945).

The experiments with temperature are of particular import in relation to possible seasonal modifications in the production of thyrotrophin.

For example, as Evans and Hegre (1940) point out, in animals which hibernate, such as frogs (Sklower, 1925; Holzapfel, 1937), certain species of lizards (Weigmann, 1932; Eggert, 1935a), turtles (Evans and Hegre, 1940), bats (Adler, 1926), hedgehogs (Schenk, 1922), and ground squirrels (Zalesky, 1935; Foster, Foster, and Meyer 1939), an inactive thyroid is present during the cold weather of winter and an active one in the warm weather of spring and summer. The reverse is true for animals that remain more or less active during the winter, such as the English sparrow (Miller, 1939), starling (Burger, 1938), albino rats (Bailiff, 1937), *Anolis* from a warm climate (Evans and Hegre, 1938), and vermilion-spotted newts (Morgan and Fales, 1942; Morgan and Johnson, 1942). In these the activity of the thyroid is higher during the cold months and lower during the warmer ones, though the differences may not always be extreme. For some of the above-named animals or closely related ones, or for other hibernators, the cytology of the pituitary throughout all or part of the year has been studied, and it has been found that changes in relative proportion of the types of cells occur at different seasons—a fact which may have some bearing on thyrotrophin production (frogs: Sklower, 1925; Zahl, 1935, 1937; newts: Copeland, 1943; snake: Hartmann, 1944; *Anolis:* Poris, 1941; woodchucks: Cushing and Goetsch, 1915; Rasmussen, 1921).

However, assays of the thyrotrophic content of the pituitary at the different seasons in the above-named animals have not been carried out. It seems plausible that in the hibernators it should vary considerably. The facts that the inactive thyroid of the hibernating ground squirrel can be stimulated by anterior pituitary administration and that hypophysectomy abolishes the annual cycle of the thyroid in these animals would lead one to expect variations in the amount of thyrotrophin present at different seasons (Zalesky, 1935; Zalesky, Wells, Overholser, and Gomez, 1941). In forms which are active in the winter, variations might be less apparent. This inference is supported by the fact that, in cattle, assays of winter and summer (June through September) pituitaries showed no significant differences in thyrotrophic potency (Byars, Friedman, Siebert, and Loeb, 1932), even though there is considerable variation in the thyroid activity during these two periods (Seidell and Fenger, 1914).

Light might be the other factor in the external environment involved in possible seasonal variations in thyrotrophin. There seem to be no assays of the thyroid-stimulating potencies of animals exposed to light or darkness, although it has been shown that continuous darkness will modify the cytology of the pituitary in rats (Pomerat, 1942), and both continuous light and darkness will affect the pituitaries of frogs as to their cytological character and their gonadotrophic content (Florentin and Stutinski, 1936; Stutinsky, 1936). Van der Meulen (1939) suggests that light as well as temperature may be concerned in the periodic molting of hens, which is largely dependent on thyroid activity controlled by the thyrotrophin production of the pars anterior. In view of the influence that light seems to have on the production of gonadotrophins in forms with annual breeding cycles (Bissonnette, 1936), it would not be surprising to find that it plays some role in relation to thyrotrophin, especially since variations in thyroid activity often occur in specific phases of the reproductive cycle. Such a study should furnish interesting data, although a clear-cut separation of the roles of temperature and light might be difficult.

Summary: The application of external stimuli or changes in certain features of the external environment, such as pressure and temperature, may be associated with more or less marked modifications of the thyrotrophic content of the pituitary of animals (Table 4). It seems likely that the nervous system may be somewhat involved in initiating the modifications.

SUMMARY

A balanced relationship between the production of thyrotrophin by the pars anterior of the pituitary and of the thyroid hormone by the thyroid gland appears to be the fundamental mechanism in the regulation of the "pituitary-thyroid axis." In considering this mechanism, however, both production-release and production-storage of the hormones must be taken into account in interpreting the functional state and potency of each gland. This is particularly important in judging the thyrotrophic content of the pars anterior in relation to the data secured by assays of the gland. A study of the cytology of the pars anterior under normal and experimental conditions may also contribute to the interpretation, even though the cellular source of thyrotrophin is still an unsettled question (Table 3).

The presence of thyrotrophin in the pars an-

terior or body fluids of an animal may be demonstrated by implanting the pituitaries or injecting their extracts or body fluids into a host of the same or another species, and finding activated thyroids in the recipient or some other response dependent on the release of the thyroid hormone by an activated thyroid. This has been done for the pituitaries of all the classes of vertebrates (Table 1). The stimulation of the thyroids of many different species by anterior pituitary substance from animals of other species, genera, or even classes, points to a lack of "zoological specificity" in the hormone.

The most generally used animals for the quantitative assay of thyrotrophin are the young guinea pig, the immature dove, the very young chick, and the anuran tadpole. In the first three, increases in thyroid weight or in height of thyroid epithelium or qualitative histological evidences of thyroid stimulation compared with the conditions in controls are the best criteria on which to base estimates of the thyrotrophic potency of the pars anterior or body fluids. In the last one, the acceleration of metamorphosis is used. This potency may be expressed in definite units. However, the exact chemical nature of the hormone is still undetermined, although the evidence indicates that it is protein in nature, possibly a pseudoglobulin, in common with other hormones of the pars anterior.

The thyrotrophic potency of the pars anterior varies considerably in different animals and even within the same species at different ages or phases of reproductive activity and sometimes in the two sexes (Table 2). Although the evidence is not wholly consistent, it has been shown for several animals that a change in potency of the pituitary (and/or body fluids) follows a variety of experimental procedures: 1) removal of certain endocrine glands, especially the thyroid, gonads, and adrenals, or administration of their hormones; 2) modifications in diet, especially by administering goitrogenic foods or drugs; and 3) subjection of animals to changes in external environment, such as pressure or temperature (Table 4). Nearly all of the potency changes, and particularly those associated with thyroid removal or treatment and with the administration of goitrogenic diets, or drugs, can be interpreted on the basis of the theory that a high level of thyroid hormone ininhibits thyrotrophin production, and that with a low level, the inhibition is removed, and the production and release of thyrotrophin are increased. The thyrotrophin then stimulates thyroid hormone production and release and thereby indirectly brings about a decrease in its own manufacture.

LIST OF LITERATURE

ABRAMOWITZ, A. A., and H. L. FEVOLD. 1937. Experimental production of exophthalmos in *Fundulus*. *Anat. Rec.*, 70 Suppl. 1: 123.

ADAMS, A. E. 1933. The effects of hypophysectomy and anterior lobe administration on the skin and thyroid of *Triton cristatus*. *J. exp. Biol.*, 10: 247–255.

——. 1934. The gonad- and thyroid-stimulating potencies of phyone and hebin. *Anat. Rec.*, 59: 349–362.

——. 1939. The riddles of the endocrines. *Sigma Delta Epsilon News*, 5: 7–8.

——, and B. C. ALLEN. 1942. The thyrotropic potency of the mouse anterior pituitary. *Anat. Rec.*, 82: 211–231.

——, and ——. 1942b. The thyrotropic potency of chick anterior pituitaries. *Anat. Rec.*, 82. Suppl.: 64.

——, and E. A. BEEMAN. 1942. The reaction of the chick thyroid to frog and mouse anterior pituitaries. *Endocrinology*, 31: 128–141.

——, and B. GRANGER. 1941. Further studies of the effects of administering anuran anterior pituitaries to immature female mice. *Amer. J. Anat.*, 69: 229–263.

——, B. GRANGER, and R. RHOADES. 1938. Stimulation of the thyroid gland of the guinea pig by anuran anterior pituitary. *Anat. Rec.*, 72: 491–501.

——, and D. JENSEN. 1944. The effect of thyroxin injections on the thyrotrophin content of the anterior pituitary of the male albino mouse. *Endocrinology*, 35: 296–308.

——, A. KUDER, and L. RICHARDS. 1932. The endocrine glands and molting in *Triturus viridescens*. *J. exp. Zool.*, 63: 1–55.

——, and A. M. MOTHES. 1945. The thyrotrophic potency of the pituitaries of albino mice with respect to age and sex. *Anat. Rec.*, 91: 21–32.

——, and G. TUKEY. 1938. The effect of administering frog anterior pituitary substance to immature female mice. *Anat. Rec.*, 71: 1–25.

ADLER, L. 1914. Metamorphosestudien an Batrachierlarven. I. Exstirpation endokriner Drüsen. A. Exstirpation der Hypophyse. *Arch. f. Entw-Mech. Org.*, 39: 21–45.

——. 1926. Der Winterschlaf. *Hb. norm. path. Physiol.*, 17: 105–133.

ALLEN, B. M. 1916. Extirpation of the hypophysis

and thyroid glands of *Rana pipiens*. *Anat. Rec.*, 11: 486.

——. 1929a. The influence of the thyroid gland and hypophysis upon growth and development of amphibian larvae. *Quart. Rev. Biol.*, 4: 325–352.

——. 1929b. The influence upon amphibian metamorphosis produced by transplants of the pars anterior of the hypophysis taken from donors of different developmental stages. *Anat. Rec.*, 44: 208.

——. 1932. The dominant role of the pars anterior of the hypophysis in initiating amphibian metamorphosis. *Anat. Rec.*, 54: 65–81.

——. 1938. The endocrine control of amphibian metamorphosis. *Biol. Rev.*, 13: 1–19.

——, E. D. Torreblanca, and J. A. Benajmin, Jr. 1929. A study upon the histogenesis of the pars anterior of the hypophysis of *Bufo* during metamorphosis. *Anat. Rec.*, 44: 208.

Amilibia, E. de, M. M. Mendizábal, and J. Botella-Llusiá. 1936. Ovarialhormone und Schilddrüsenfunktion. *Klin. Wschr.*, 15: 1001–1004.

Andersen, D. H., and H. S. Kennedy. 1933. The effect of gonadectomy on the adrenal, thyroid, and pituitary glands. *J. Physiol.*, 79: 1–30.

Anderson, E. M., and J. B. Collip. 1933. Thyreotropic hormone of anterior pituitary. *Proc. Soc. exp. Biol. N. Y.*, 30: 680–683.

——, and ——. 1934a. Preparation and properties of an antithyrotropic substance. *Lancet*, p. 784–791.

——, and ——. 1934b. Studies on the physiology of the thyreotropic hormone of the anterior pituitary. *J. Physiol.*, 82: 11–25.

Aron, M. 1929. Action de la préhypophyse sur la thyroïde chez le cobaye. *C. R. Soc. Biol. Paris*, 102: 682–684.

——. 1930a. Particularités histologiques de la réaction de la thyroïde aux extraits de lobe antérieur d'hypophyse. *C. R. Soc. Biol. Paris*, 103: 145–147.

——. 1930b. Indications apportées par la méthode des injections hypophysaires sur le fonctionnement de la thyroïde et ses tests morphologiques. *C. R. Soc. Biol. Paris*, 103: 148–150.

——. 1930c. Action combinée de la thyroxine et de l'extrait préhypophysaire sur la thyroïde chez le cobaye. *C. R. Soc. Biol. Paris*, 104: 96–98.

——. 1930d. Méthode biologique de diagnostic des états d'hyperactivité et d'hypoactivité de la préhypophyse chez l'homme. *C. R. Soc. Biol. Paris*, 105: 585–586.

——. 1930e. L'hormone préhypophysaire excito-sécrétrice de la thyroïde. (Contribution à l'étude du fonctionnement thyroïdien). *Rev. fr., endocrinol.*, 8: 472–520.

——. 1931. Recherches sur les indices d'activité de la préhypophyse selon l'age et l'espèce, par la méthode du titrage physiologique de l'hormone dans le milieu intérieur, et sur leur correspondance avec les manifestations morphologiques de l'activité de la thyroïde. *C. R. Soc. Biol. Paris*, 106: 609–611.

——, and J. Benoit. 1931. Influence de la castration sur le taux d'hormone préhypophysaire excito-sécrétrice de la thyroïde présent, dans le milieu intérieur, chez le cobaye. *C. R. Soc. Biol. Paris*, 108: 784–786.

——, and ——. 1932. Action antagoniste de la thyréo-stimuline préhypophysaire et de la folliculine ovarienne sur le fonctionnement thyroïdien. *C. R. Soc. Biol. Paris*, 109: 923–925.

——, and M. Klein. 1930. Sur la présence, dans l'urine humaine, d'une substance douée de la même action sur la thyroïde que l'extrait préhypophysaire, et sur l'interprétation de la réaction de diagnostic de la grossesse. *C. R. Soc. Biol. Paris*, 103: 702–704.

——, C. Van Caulaert, and J. Stahl. 1931. L'équilibre entre l'hormone préhypophysaire et l'hormone thyroïdienne dans le milieu intérieur, a l'état normal et a l'état pathologique. *C. R. Soc. Biol. Paris*, 107: 64–66.

Astwood, E. B., J. Sullivan, A. Bissell, and R. Tyslowitz. 1943. Action of certain sulfonamides and of thiourea upon the function of the thyroid gland of the rat. *Endocrinology*, 32: 210–225.

Baillif, R. N. 1937. Cytological changes in the rat thyroid following exposure to heat and cold, and their relationship to the physiology of secretion. *Amer. J. Anat.*, 61: 1–19.

——. 1938. Microscopic changes in the hypophysis of the albino rat following exposure to cold, and their relationship to the physiology of secretion. *Amer. J. Anat.*, 62: 475–495.

Bastenie, P. 1940. Détection de l'hormone thyréotrope dans les urines. Méthode et résultats. *Arch. internat. Méd. expér.*, 14: 111–122.

Bates, R. W., O. Riddle, and E. L. Lahr. 1935. An assay of three hormones present in anterior pituitaries of seven types of cattle classified for age, sex and stage of reproduction. *Amer. J. Physiol.*, 113: 259–264.

——, ——, and ——. 1941. A strain difference in responsiveness of chick thyroids to thyrotropin and a step-wise increase during three years in thyroid weights of Carneau pigeons. *Endocrinology*, 29: 492–497.

Baumann, E. J., N. Metzger, and D. Marine. 1944. Mode of action of thiourea on the thyroid gland of rabbits. *Endocrinology*, 34: 44–49.

Belasco, I. J., and J. R. Murlin. 1941. The effect of thyroxin and thyrotropic hormone on the basal metabolism and thyroid tissue respiration of rats at various ages. *Endocrinology*, 28: 145–152.

BENAZZI, M. 1929. Castrazione ovarica e ghiandola tiroide. *Boll. Soc. Ital. Biol. sper.*, 4: 679–681.

——. 1933. L'ormone follicolare inibisce la funzionalità tiroidea. *Boll. Soc. Ital. Biol. sper.*, 8: 790–794.

——. 1938. Sulla specificità zoologica degli ormoni gonadotropi preipofisari. *Boll. Soc. Ital. Biol. sper.*, 13: 720–721.

——. 1940. Il mio concetto di specificità zoologica relativa degli ormoni gonadotropi preipofisari: nuove conferme e prospettive. *Atti R. Accad. Fisiocritici Siena*, 8: 1–3.

BENOIT, J., and M. ARON. 1931. Influence de la castration sur le taux d'hormone préhypophysaire excito-sécrétrice de la thyroïde présent dans le milieu intérieur chez le coq et le canard. Notion d'un cycle saisonnier de l'activité préhypophysaire chez ces oiseaux. *C. R. Soc. Biol. Paris*, 108: 786–788.

BERGMAN, A. J., and C. W. TURNER. 1939. A comparison of the guinea pig and chick thyroid in the assay of the thyrotropic hormone. *Endocrinology*, 24: 656–664.

——, and ——. 1941. Thyrotropic hormone content of rabbit pituitary during growth. *Endocrinology*, 29: 313–319.

——, and ——. 1943. Effect of pregnancy and lactation upon the thyrotropic hormone of the rabbit. *Endocrinology*, 32: 59–63.

BISSONNETTE, T. H. 1936. Sexual photoperiodicity. *Quart. Rev. Biol.*, 11: 371–386.

BODART, F., and K. FELLINGER. 1936. Über die thyreotrope Wirkung des Serums bei endokrinen Erkrankungen. *Wien. klin. Wschr.*, 49: 1286–1287.

BOMSKOV, C., and E. SCHNEIDER. 1939. Über Beziehungen des Vitamins E zur Ovarial- und Schilddrüsenfunktion. *Arch. exp. Path. Pharmak.*, 191: 715–734.

BURGER, J. W. 1938. Cyclic changes in the thyroid and adrenal cortex of the male starling, *Sturnus vulgaris*, and their relation to the sexual cycle. *Amer. Nat.*, 72: 562–570.

BYARS, L. T., H. FRIEDMAN, W. J. SIEBERT, and L. LOEB. 1932. Are seasonal variations of thyroid gland dependent upon corresponding variations in anterior pituitary? *Proc. Soc. exp. Biol. N. Y.*, 29: 797–799.

CAMERON, A. T. 1945. *Recent Advances in Endocrinology*. 5th edit. The Blakiston Co., Philadelphia.

CANZANELLI, A., and D. RAPPORT. 1938. The effect of thyrotropic hormone, alone and with other substances, on the in vitro O_2 consumption of thyroid and liver. *Endocrinology*, 22: 73–79.

CHANCE, M. R. A., I. W. ROWLANDS, and F. G. YOUNG. 1939. Species variation in thyrotrophic, gonadotrophic, and prolactin activities of the anterior hypophyseal tissue. *J. Endocrin.*, 1: 239–260.

CHARIPPER, H. A., and E. L. COREY. 1930. Studies on amphibian endocrines. V. Accelerated metamorphosis of *Rana clamitans* larvae by means of implants of fresh anterior pituitary from adult *Necturus maculosus*. *Anat. Rec.*, 45: 258.

CH'EN, G., and H. B. VAN DYKE. 1934. Amount of thyroid-stimulating hormone in anterior pituitary of the thyroidectomized rabbit. *Proc. Soc. exp. Biol. N. Y.*, 32: 484–485.

——, and ——. 1936. The amount of thyroid-stimulating hormone in the anterior lobe of the pituitary of the thyroidectomized rabbit. *Chinese J. Physiol.*, 10: 285–296.

CHOUKE, S. 1930. The effect of castration on the proliferative activity and structure of the thyroid gland in guinea pigs. *Endocrinology*, 14: 12–16.

CLARK, H. M. 1935. A prepubertal reversal of the sex difference in the gonadotropic hormone content of the pituitary gland of the rat. *Anat. Rec.*, 61: 175–192.

COLLIP, J. B. 1934. Some recent advances in the physiology of the anterior pituitary. *J. Mt. Sinai Hosp.*, 1: 28–71.

——. 1935. Diabetogenic, thyrotropic, adrenotropic and parathyrotropic factors of the pituitary. *J. Amer. med. Assoc.*, 104: 827–832. (Glandular Physiology and Therapy, 1st edit.)

——. 1940. Corticotropic (adrenotropic), thyrotropic and parathyrotropic factors. *J. Amer. med. Ass.*, 115: 2073–2079. (Glandular Physiology and Therapy, 2nd. ed., 1942.)

——, and E. M. ANDERSON. 1935. Studies on the thyrotropic hormone of the anterior pituitary. *J. Amer. med. Ass.*, 104: 965–969.

——, H. SELYE, and D. L. THOMSON. 1934. Histological changes in the hypophysis produced by chronic administration of hypophyseal extracts. *Proc. Soc. Exp. Biol. N. Y.*, 31: 682–683.

COPE, C. L. 1937. (See A. Loeser, 1937. Hyperthyroidism and the thyrotropic hormone of the pituitary. *Brit. med. J.*, 1: 1276–1278.)

——. 1938a. The young chick as test for the thyrotropic hormone. *J. Physiol.*, 94: 358–364.

——. 1938b. The anterior pituitary lobe in Graves' disease and in myxoedema. *Quart. J. Med.*, 31: 151–170.

COPELAND, D. E. 1943. Cytology of the pituitary gland in developing and adult *Triturus viridescens*. *J. Morph.*, 72: 379–409.

CUSHING, H., and L. M. DAVIDOFF. 1927a. The pathological findings in four autopsied cases of acromegaly with a discussion of their significance. *Rockefeller Inst. Mon.*, #22: 1–131.

——, and ——. 1927b. Studies in acromegaly. IV.

The basal metabolism. *Arch. int. Med.*, 39: 673–697.

——, and E. GOETSCH. 1915. Hibernation and the pituitary body. *J. exp. Med.*, 22: 25–47.

D'ANGELO, S. A. 1941. An analysis of the morphology of the pituitary and thyroid glands in amphibian metamorphosis. *Amer. J. Anat.*, 69: 407–437.

——, A. S. GORDON, and H. A. CHARIPPER. 1941. A study of pituitary-adrenal-thyroid function in the starved guinea pig. *Anat. Rec.*, 81: 4, Suppl.; 96.

——, ——, and ——. 1942. Thyrotropic hormone assay in the tadpole. *Endocrinology*, 31: 217–225.

DAWSON, A. B. 1942. Some morphological aspects of the secretory process. *Fed. Proc.*, 1: 233–240.

——, and R. J. JIMENEZ. 1933. The response of the hedonic glands of the male *Triturus viridescens* to heteroplastic implants of anterior pituitary. *Anat. Rec.*, 55: 279–289.

DEFOREST, E. M. 1939. The response of the female newt to implants of anterior pituitary of the mouse. Honor Paper, Mount Holyoke College (Unpub.).

DEFREMERY, P. 1935. Die Wirkung des Dijodtyrosins auf die Rattenschilddrüse. *Acta brev. Neerland.*, 5: 35–36.

DEMPSEY, E. W. 1944. Fluorescent and histochemical reactions in the rat thyroid gland at different states of physiological activity. *Endocrinology*, 34: 27–38.

——, and E. B. ASTWOOD. 1943. Determination of the rate of thyroid hormone secretion at various environmental temperatures. *Endocrinology*, 32: 509–518.

——, and U. U. UOTILA. 1940. The effect of pituitary stalk section upon reproductive phenomena in the female rat. *Endocrinology*, 27: 573–579.

DE ROBERTIS, E., and E. DEL CONTE. 1944. Método citológico para la determinación de la hormona tireotropa de la hipófisis. *Rev. Soc. Argent. Biol.*, 20: 88–99.

DIECKHOFF, J., and E. SCHULZE. 1937. Hypophysenvorderlappen, Schilddrüse und Nebennierenrinde bei experimenteller Diphtherieintoxikation. *Arch. exp. Path. Pharmak.*, 186: 462–474.

DOMM, L. V. 1931. Precocious development of sexual characters in the fowl by homeoplastic hypophyseal implants. I. The male. II. The female. *Proc. Soc. exp. Biol. N. Y.*, 29: 308–312.

——, and H. B. VAN DYKE. 1932. Precocious development of sexual characters in the fowl by daily injections of hebin. I. The male. II. The female. *Proc. Soc. exp. Biol. N. Y.*, 30: 349–353.

DRILL, V. A. 1943. Interrelations between thyroid function and vitamin metabolism. *Physiol. Rev.*, 23: 355–379.

EGGERT, B. 1936a. Zur Morphologie und Physiologie der Eidechsen-Schilddrüse. I. Das jahreszeitliche Verhalten der Schilddrüse von *Lacerta agilis* L., *L. vivipara* Jacq. und *L. muralis* Laur. *Z. wiss. Zool.*, 147: 205–262.

——. 1936b. Zur Morphologie . . . . II. Über die Wirkung von hohen und niedrigen Temperaturen, von Thyroxin und thyreotropem Hormon auf die Schilddrüse. *Z. wiss. Zool.*, 147: 537–594.

ELLIS, C. H., and C. A. G. WIERSMA. 1945. Influence of electronarcosis on secretory activity of the pituitary gland. *Proc. Soc. exp. Biol. N. Y.*, 58: 160–162.

EMERSON, K., JR. 1937. On the specificity of the thyreotropic action of the anterior pituitary gland. *Bull. Johns Hopkins Hosp.*, 60: 358–368.

——, and W. C. CUTTING. 1938. Urinary thyrotropic hormone. *Endocrinology*, 23: 439–445.

ETKIN, W. 1938. The development of thyrotropic function in pituitary grafts in the tadpole. *J. exp. Zool.*, 77: 347–377.

EVANS, L. T. 1935. The effects of antuitrin S and sheep pituitary extract on the female lizard, *Anolis carolinensis*. *Biol. Bull.*, 68: 355–359.

——, and E. HEGRE. 1938. The effects of ovarian hormones and seasons on *Anolis carolinensis*. I. The thyroid. *Anat. Rec.*, 72: 1–10.

——, and ——. 1940. Endocrine relationships in turtles. *Endocrinology*, 27: 144–148.

FELLINGER, K. 1936. Klinische und experimentelle Untersuchungen über das Verhalten und die Bedeutung des thyreotropen Hormons im Blute. *Wien. Arch. inn. Med.*, 29: 375–406.

FLORENTIN, P., and F. STUTINSKI. 1936. Modifications cytologiques de la gland pituitaire des Grenouilles maintenues a l'obscurité. *C. R. Soc. Biol. Paris*, 122: 674–676.

FOGLIA, V. G. 1940. Acción tirotrópica de la hipófisis del sapo *Bufo arenarum* Hensel sobre aves y mamiferos. *Rev. Soc. Argent. Biol.*, 16: 381–389.

——. 1941. Hormonal action of the toad hypophysis on mammals. *Endocrinology*, 29: 503–513.

FOSTER, M. A., R. C. FOSTER, and R. K. MEYER. 1939. Hibernation and the endocrines. *Endocrinology*, 24: 603–612.

FRANCK, S. 1936. Histophysiologie de la préhypophyse. Action de l'hormone thyroïdienne et de l'hormone de la cortico-surrénale sur l'hypophyse du cobaye. *C. R. Soc. Biol. Paris*, 123: 335–338.

——. 1937. Histophysiologie. . . . Préhypophyse et gland thyroïde soumises a l'action de la folliculine. *C. R. Soc. Biol. Paris*, 125: 573–576.

GALLI-MAININI, C. 1941. Effect of thyroid and thyrotropic hormones upon oxygen consumption (QO_2) of the thyroid of the guinea pig. *Endocrinology*, 29: 674–679.

——. 1943. La tiroides del sapo para la medición de la hormona tirotropa. *Rev. Soc. Argent. Biol.*, 19: 210–216.

GEILING, E. M. K. 1937. The pituitary gland of whales. *Science*, 85: 22–23.

GIEDOSZ, B. 1934. Über thyreotrope Substanzen im menschlichen Harn. *Klin. Wschr.*, 13: 1507.

GORBMAN, A. 1940. Suitability of the common goldfish for assay of thyrotropic hormone. *Proc. Soc. exp. Biol. N. Y.*, 45: 772–773.

——. 1941. Comparative anatomy and physiology of the anterior pituitary. *Quart. Rev. Biol.*, 16: 294–310.

GORDON, A. S., E. D. GOLDSMITH, and H. A. CHARIPPER. 1945. Thyrotrophic hormone content of the blood sera and pituitary glands of thiourea-, sulfadiazine-treated and thyroidectomized rats. *Endocrinology*, 36: 53–61.

——, F. J. TORNETTA, S. A. D'ANGELO, and H. A. CHARIPPER. 1943. Effects of low atmospheric pressures on the activity of the thyroid, reproductive system and anterior lobe of the pituitary in the rat. *Endocrinology*, 33: 366–383.

GRANT, M. P. 1930. The release of follicular colloid from the thyroid of *Necturus maculosus* following heteroplastic anterior-pituitary implants. *Anat. Rec.*, 46: 205–221.

——. 1931. The release of follicular colloid from the thyroid of *Amblystoma jeffersonianum* following heteroplastic anterior-pituitary implants. *Anat. Rec.*, 49: 373–395.

GRIESBACH, W. E. 1941. Studies on experimental goitre. II. Changes in the anterior pituitary of the rat, produced by *Brassica* seed diet. *Brit. J. exp. Path.*, 22: 245–249.

——, T. H. KENNEDY, and H. D. PURVES. 1941. Studies on experimental goitre. III. The effect of goitrogenic diet on hypophysectomized rats. *Brit. J. exp. Path.*, 22: 249–254.

——, ——, and ——. 1945. Studies . . . VI. Thyroid adenomata in rats on *Brassica* seed diet. *Brit. J. exp. Path.*, 26: 18–24.

——, and H. D. PURVES. 1943a. Studies . . . V. Pituitary function in relation to goitrogenesis and thyroidectomy. *Brit. J. exp. Path.*, 24: 174–184.

——, and ——. 1943b. The assay of thyrotropic activity by the cell height response in guinea-pigs. *Brit. J. exp. Path.*, 24: 185–192.

——, and ——. 1945. The significance of the basophil changes in the pituitary accompanying various forms of thyroxine deficiency. *Brit. J. exp. Path.*, 26: 13–17.

GROBSTEIN, C. 1938. Appearance of vacuolated cells in hypophysis of *Triturus torosus* following bilateral thyroidectomy. *Proc. Soc. Exp. Biol. N. Y.*, 38: 801–803.

GÜTHERT, H. 1940. Der Einfluss von Hypophysenvorderlappenextrakten und Colchicin auf Korngrösze und Kernteilung in der Schilddrüse. *Arch. path. Anat.*, 307: 37–70.

HAIST, R. E. 1944. Factors affecting the insulin content of the pancreas. *Physiol. Rev.*, 24: 409–444.

HARTMANN, J. F. 1944. Seasonal cytological changes in the anterior hypophysis of the garter snake. *Amer. J. Anat.*, 75: 121–149.

HELLBAUM, H. W. 1936. The cytology of snake thyroids following hypophysectomy, activation and ultracentrifuging. *Anat. Rec.*, 67: 53–67.

HERTZ, S., and E. G. OASTLER. 1936. Assay of blood and urine for thyreotropic hormone in thyrotoxicosis and myxedema. *Endocrinology*, 20: 520–525.

HEYL, J. G., and E. LAQUEUR. 1934. Zur quantitativen Bestimmung der thyreotropen Wirkung von Hypophysenvorderlappenpräparaten und die Einheit des thyreotropen Hormons. *Arch. intern. Pharmacodynam.*, 49: 338–354.

HOHLWEG, W., and K. JUNKMANN. 1933. Über die Beziehungen zwischen Hypophysenvorderlappen und Schilddrüse. *Pflüg. Arch. ges. Physiol.*, 232: 148–158.

HOLZAPFEL, R. A. 1937. The cyclic character of hibernation in frogs. *Quart. Rev. Biol.*, 12: 65–84.

HOSKINS, R. G. 1941. *Endocrinology*. W. W. Norton & Co., New York.

HOUSSAY, B. A. 1932. Hypophyse et thyroïde. Réaction de la thyroïde du rat en parabiose ou injecté avec l'extrait anté-hypophysaire. *C. R. Soc. Biol. Paris*, 111: 459–461.

——. 1943. Acción de la hipófisis de *Xenopus laevis* sobre el *Bufo arenarum*. *Rev. Soc. Argent. Biol.*, 19: 182–186.

——, A. BIASOTTI, and A. MAGDALENA. 1932. Hypophyse et thyroïde. Action de l'extrait anté-hypophysaire sur l'histologie de la thyroïde du chien. *C. R. Soc. Biol. Paris*, 110: 834–836.

——, A. NOVELLI, and R. SAMMARTINO. 1932. Hypophyse et thyroïde. Action excito-thyroïdienne de l'hypophyse des animaux thyroprives. *C. R. Soc. Biol. Paris*, 111: 830–832.

HUNDHAUSEN, G. 1939. Über den Einfluss verminderter Nahrungszufuhr auf Schilddrüse und thyreotropes Hormon des Hypophysen-Vorderlappens. *Arch. exp. Path. Pharmak.*, 192: 634–638.

——, and E. SCHULZE. 1939. Über die Beziehungen zwischen Schilddrüse und Hypophysenvorderlappen bei B_1-Avitaminose. *Arch. exp. Path. Pharmak.*, 191: 570–580.

INGRAM, W. R. 1929. Studies of amphibian neoteny. II. The interrelation of thyroid and pituitary in the metamorphosis of neotenic anurans. *J. exp. Zool.*, 53: 387–410.

JENSEN, D. 1945. The effect of low thyroxin dosage on the thyrotrophic potency of the pars anterior of the mouse. *Anat. Rec.*, 91: 283.

JONES, M. S. 1939. A study of thyrotropic hormone in clinical states. *Endocrinology*, 24: 665–671.

JORES, A. 1938a. Experimentelle Untersuchungen über die Wirkung der Nebennieren auf die Hypophyse. II. Die Änderungen in dem Gehalt der Hypophysen weisser Ratten an thyreotropem Hormon bei Nebennierenmangel und nach Injektion von Cortidyn und Adrenalin. *Z. ges. exp. Med.*, 102: 285–288.

——. 1938b. Experimentelle Untersuchungen. . . . III. Über die histologischen Änderungen des Hypophysenvorderlappens nach Zufuhr von Adrenalin und Cortidyn. *Z. ges. exp. Med.*, 102: 289–291.

JORGENSEN, M. N., and N. J. WADE. 1941. The preparation of thyrotropic hormone. *Endocrinology*, 28: 406–411.

JUNKMANN, K., and W. SCHOELLER. 1932. Über das thyreotrope Hormon des Hypophysenvorderlappens. *Klin. Wschr.*, 11: 1176–1177.

KAMPELMANN, F., and E. SCHULZE. 1937. Kohlenoxyd und Hypophysenvorderlappen. *Arch. exp. Path. Pharmak.*, 184: 152–155.

KEATY, C., and A. J. STANLEY. 1940–41. Seasonal variations in gonadotropic and thyrotropic hormones of the pituitary of *Rana catesbeiana*. *Anat. Rec.*, 78: 4, Suppl. 140.

KENNEDY, T. H., and H. D. PURVES. 1941. Studies on experimental goitre. I. The effects of Brassica seed diets on rats. *Brit. J. exp. Path.*, 22: 241–244.

KESTON, A. S., E. D. GOLDSMITH, A. S. GORDON, and H. A. CHARIPPER. 1944. The effect of thiourea upon the metabolism of iodine by rat thyroid. *J. biol. Chem.*, 152: 241–244.

KIPPEN, A. A., and L. LOEB. 1936. The effect of gonadectomy on the thyroid gland in the guinea pig. *Endocrinology*, 20: 201–209.

KLATT, B. 1931. Hypophysenexstirpation und -implantation an Tritonlarven. *Arch. EntwMech. Org.*, 123: 747–791.

——. 1933. Weitere Versuche (Hypophysenexstirpationen und -implantationen) an Tritonlarven. *Arch. EntwMech. Org.*, 130: 79–108.

KRICHESKY, B. 1934. The response of *Rana catesbeiana* larvae to injections of antuitrin S and phyone. *Physiol. Zool.*, 7: 178–191.

KRJLOW, L. H., and A. J. STERNBERG. 1932. Die Schilddrüsenkolloidveränderung bei Kaninchen unter dem Einfluss des Koitus und der Schwangerschaft. *Endokrinologie* 10: 37.

KROGH, M., and H. OKKELS. 1933a. Sur l'histophysiologie du corps thyroide. Stades initiaux de la sécrétion thyroïdienne. *C. R. Soc. Biol. Paris*, 112: 1694–1696.

——, and ——. 1933b. L'hormone thyréostimulante préhypophysaire est-elle présente dans l'urine? *C. R. Soc. Biol. Paris*, 113: 635–638.

KUMMER, H. J. 1938. Die morphologischen Frühveränderungen an der Schilddrüse nach einer einmaligen Injektion von thyreotropem Hormon. *Endokrinologie*, 20: 326–333.

KUNDE, M. M., F. E. D'AMOUR, R. G. GUSTAVSON, and A. J. CARLSON. 1930. Effect of estrin injections on reproductive organs, hypophysis, kidney, adrenals, thyroid and blood vascular system. *Proc. Soc. exp. Biol. N. Y.*, 28: 122–123.

KUNKEL, P., and L. LOEB. 1935. Effects of human anterior pituitary gland on sex organs and thyroid of the guinea pig. *Proc. Soc. exp. Biol. N. Y.*, 32: 1413–1417.

KUSCHINSKY, G. 1933. Über die Bedingungen der Sekretion des thyreotropen Hormons der Hypophyse. *Arch. exp. Path. Pharmak.*, 170: 510–533.

——. 1935. Über den Einfluss verschiedener Temperaturen auf die Sekretion des thyreotropen Hormons. *Arch. exp. Path. Pharmak.*, 179: 726–737.

LÁNCZOS, A., and M. ÁTS. 1941. Tätigkeitssteigerung der Schilddrüse durch thyreotropes Hormon beim metamorphosierten Kaltblüter. *Arch. exp. Path. Pharmak.*, 197: 123–129.

LARSON, R. A., F. R. KEATING, JR., W. PEACOCK, and R. W. RAWSON. 1945a. A comparison of the effect of thiouracil and of injected thyrotropic hormone on the collection of radioactive iodine and the anatomic changes induced in the thyroid of the chick. *Endocrinology*, 36: 149–159.

——, ——, ——, and ——. 1945b. The effect of thiouracil on the collection of radioactive iodine by the thyroid of the chick. *Endocrinology*, 36: 160–169.

LEBEDEWA, N. S. 1936. Der histophysiologische Effekt der Thyreoidektomie im Hypophysenvorderlappen der Ratte. *Arch. exp. Path. Pharmak.*, 183: 15–29.

LEBLOND, C. P., W. C. PEACOCK, and R. D. EVANS. 1943. Metabolism of radioactive iodine in the thyroids of rats kept at low temperature. *Fed. Proc.*, 2: 28–29.

LEIBY, G. M. 1933. Effect of theelol on weights of pituitary, adrenal and thyroid. *Proc. Soc. exp. Biol. N. Y.*, 31: 15–17.

LEONARD, S. L. 1937. Luteinizing hormone in bird hypophyses. *Proc. Soc. exp. Biol. N. Y.*, 37: 566–568.

LERMAN, J. 1941. Physiology of the thyroid gland. *J. Amer. med. Ass.*, 117: 349–359. (Glandular Physiology and Therapy, 2nd ed., 1942).

LINNEMANN, H. 1939. Über den Einfluss antithyreotroper Substanzen auf Schilddrüse und Hypophysenvorderlappen bei der experimentellen Kohlenoxydhyperthyreose. *Arch. exp. Path. Pharmak.*, 192: 300–308.

LOEB, L. 1932a. Specificity in action of anterior pituitary of different mammals and urine of pregnant women on ovary and thyroid. *Proc. Soc. exp. Biol. N. Y.*, 29: 642–644.

——. 1932b. Effects of anterior pituitary from various species on sex [organs] and thyroid of immature guinea pigs. *Proc. Soc. exp. Biol. N. Y.*, 29: 1128–1131.

——. 1932c. The specificity in the action of the anterior pituitary of different mammals as well as of urine of pregnant women on the sex organs and thyroid glands of immature female guinea pigs. *Endocrinology*, 16: 129–145.

——, and R. B. BASSETT. 1929. Effect of hormones of anterior pituitary on thyroid gland in the guinea-pig. *Proc. Soc. exp. Biol. N. Y.*, 26: 860–862.

——, and ——. 1930. Comparison of effects of various preparations of anterior pituitary gland on thyroid of guinea pig. *Proc. Soc. exp. Biol. N. Y.*, 27: 490–492.

——, ——, and H. FRIEDMAN. 1930. Further investigations concerning the stimulating effect of anterior pituitary gland preparation on the thyroid gland. *Proc. Soc. exp. Biol. N. Y.*, 28: 209–213.

——, and H. FRIEDMAN. 1933. The two main types of anterior pituitary gland present in different species of animals. *Proc. Soc. exp. Biol. N. Y.*, 30: 741–744.

——, J. SAXTON and S. J. HAYWARD. 1936. The relationship of the anterior pituitary gland to thyroid and ovary. *Endocrinology*, 20: 511–519.

LOESER, A. 1934. Der Einfluss des Ovariums auf die Sekretion des thyreotropen Hormons der Hypophyse. *Klin. Wschr.*, 13: 766–767.

——. 1937. Hyperthyroidism and the thyrotropic hormone of the pituitary. *Brit. med. J.*, 1: 1276–1278.

LOWE, G. H., JR., A. C. IVY, and S. BROCK. 1945. The effects of bilateral cervical sympathectomy on thyroid activity. *Endocrinology*, 36: 130–136.

MACKENZIE, C. G., and J. B. MACKENZIE. 1943. Effect of sulfonamides and thioureas on the thyroid gland and basal metabolism. *Endocrinology*, 32: 185–209.

MACKENZIE, J. B., and C. G. MACKENZIE. 1944. Effect of prolonged and intermittent sulfonamide feeding on the basal metaboïic rate, thyroid and pituitary. *Bull. Johns Hopkins Hosp.*, 74: 85–97.

MAGDALENA, A. 1932. Hypophyse et thyroïde. Action de l'ablation ou de l'implantation de l'hypophyse sur la thyroïde du crapaud. *C. R. Soc. Biol. Paris*, 112: 489–491.

MARINE, D., E. J. BAUMANN, and S. H. ROSEN. 1934. Effect of ascorbic acid on thyroid and suprarenals of guinea pigs. *Proc. Soc. exp. Biol. N. Y.*, 31: 870–873.

——, S. H. ROSEN, and C. SPARK. 1935. Effect of iodine and desiccated thyroid on anterior pituitary of goitrous and thyroidectomized rabbits. *Proc. Soc. exp. Biol. N. Y.*, 32: 803–810.

MASON, E. M. 1938. Assay of thyrotropic hormone. *Nature, Lond.*, 142: 480–481.

MEANS, J. H. 1939. Diseases of the thyroid gland *New Eng. J. Med.*, 221: 820–825.

MILLER, D. S. 1938. Lack of refractoriness to prolonged thyrotropin administration in birds. *Proc. Soc. exp. Biol. N. Y.*, 38: 453–455.

——. 1939. A study of the physiology of the sparrow thyroid. *J. exp. Zool.*, 80: 259–285.

MIXNER, J. P., E. P. REINEKE, and C. W. TURNER. 1944. Effect of thiouracil and thiourea on the thyroid gland of the chick. *Endocrinology*, 34: 168–174.

MORGAN, A. H., and C. H. FALES. 1942. Seasonal conditions and effects of low temperature in the thyroid glands of amphibians. I. Adult *Triturus viridescens*. *J. Morph.*, 71: 357–389.

——, and B. J. JOHNSON. 1942. Seasonal conditions. . . . II. Terrestrial phase of *Triturus viridescens*. *J. Morph.*, 70: 301–321.

MULINOS, M. G., and L. POMERANTZ. 1940. Pseudohypophysectomy. A condition resembling hypophysectomy produced by malnutrition. *J. Nutrit.*, 19: 493–504.

MÜLLER, R., H. EITEL, and A. LOESER. 1935. Der thyreotrope Wirkstoffgehalt der menschlichen Hypophyse. *Arch. exp. Path. Pharmak.*, 179: 427–439.

NATHANSON, I. R., A. M. BRUES, and R. W. RAWSON. 1940. Effect of testosterone propionate upon thyroid and parathyroid glands of intact immature female rat. *Proc. Soc. exp. Biol. N. Y.*, 43: 737–740.

NOETHER, P. 1932. Über die Wirkung des thyreotropen Hormons des Hypophysenvorderlappens auf das Leghuhn. *Klin. Wschr.*, 11: 1702–1703.

PAAL, H., and H. O. KLEINE. 1933 Über die Abhängigkeit der Schilddrüsen-funktion von alimentären und hormonalen Faktoren. *Beitr. path. Anat.*, 91: 322–342.

PASCHKIS, K. E., A. CANTAROW, and A. E. RAKOFF. 1944. Experimental and clinical studies on the action of thiourea and thiouracil. *Endocrinology*, 5: 200.

PAUL, A. K. 1945. The effect of injections of adrenalin on the endocrine glands of the male albino mouse. Master's Thesis, Mount Holyoke College (Unpub.).

PERRY, J. C. 1943. Gonad and related endocrine response of female rats to experimental hyperadrenalism. *Anat. Rec.*, 87: 415–427.

PINCUS, G., and N. WERTHESSEN. 1933. The continued injection of oestrin into young rats. *Amer. J. Physiol.*, 103: 631–636.

POMERAT, G. R. 1942. Cell changes in the pituitary and ovary of the white rat following exposure to constant light or darkness. *Anat. Rec.*, 82: 531–542.

PORIS, E. G. 1941. Studies on the endocrines of reptiles. II. Variations in the histology of the

hypophysis of *Anolis carolinensis*, with a note on the Golgi configuration in cells of the pars anterior and pars intermedia. *Anat. Rec.*, 80: 99–121.

PRATT, M. A. 1943. The thyrotropic potency of the anterior pituitary of castrated male albino mice. Honor Paper, Mount Holyoke College (Unpub.).

PURVES, H. D. 1943. Studies on experimental goitre. IV. The effect of di-iodotyrosine and thyroxine on the goitrogenic action of *Brassica* seeds. *Brit. J. exp. Path.*, 24: 171–173.

RASMUSSEN, A. T. 1921. The hypophysis cerebri of the woodchuck (*Marmota monax*) with special reference to hibernation and inanition. *Endocrinology*, 5: 33–66.

RAWSON, R. W., R. E. CORTELL, W. PEACOCK, and J. H. MEANS. 1944. The effect of thiouracil and of potassium thiocyanate on the collection of radioactive iodine by the thyroids of animals and man. *Endocrinology*, 35: 201–202.

——, R. D. EVANS, J. H. MEANS, W. C. PEACOCK, J. LERMAN, and R. E. CORTELL. 1944. The action of thiouracil upon the thyroid gland in Graves' disease. *J. clin. Endocrin.*, 4: 1–11.

——, R. M. GRAHAM, and C. B. RIDDELL. 1943. Physiological reactions of the thyroid stimulating hormone of the pituitary. II. The effect of normal and pathological human thyroid tissues on the activity of the thyroid stimulating hormone. *Ann. int. Med.*, 19: 405–414.

——, S. HERTZ, and J. H. MEANS. 1943. Thiocyanate goiter in man. *Ann. int. Med.*, 19: 829–842.

——, and W. T. SALTER. 1940. Microhistometric assay of thyrotropic hormone in day-old chicks. *Endocrinology*, 27: 155–157.

——, and P. STARR. 1938. Direct measurement of height of thyroid epithelium. A method of assay of thyrotropic substance; clinical application. *Arch. int. Med.*, 61: 726–738.

——, G. D. STERNE, and J. C. AUB. 1942. Physiological reactions of the thyroid-stimulating hormone of the pituitary. I. Its inactivation by exposure to thyroid tissue in vitro. *Endocrinology*, 30: 240–245.

REECE, R. P., and C. W. TURNER. 1937. The lactogenic and thyrotropic hormone content of the anterior lobe of the pituitary gland. *Univ. Mo. agric. Exp. Sta. Res. Bull.*, 266: 1–104.

REESE, J. D., A. A. KONEFF, and M. B. AKIMOTO. 1939. Anterior pituitary changes following adrenalectomy in the rat. *Anat. Rec.*, 75: 373–404.

——, ——, and P. WAINMAN. 1943. Cytological differences between castration and thyroidectomy basophils in the rat hypophysis. *Essays in Biology*, pp. 471–485.

REFORZO-MEMBRIVES, J. 1938. Estudios sobre la relacion entre hipófisis y tiroides. Tesis del Doctorado en Med., Univ. Nac. Buenos Aires.

——. 1940. Acción tirodepresora de la hipófisis de los animales tratados con tiroides. *Rev. Soc. Argent. Biol.*, 16: 325–339.

——. 1942. Acción metabólico depresora de la hipófisis de ratas tratados con tiroides. *Rev. Soc. Argent. Biol.*, 18: 556–565.

——. 1943. Thyroid-inhibiting action of the hypophyses of rats fed with thyroid. *Endocrinology*, 32: 263–270.

REICHERT, F. L. 1928. The results of replacement therapy in an hypophysectomized puppy: four months of treatment with daily pituitary heterotransplants. *Endocrinology*, 12: 451–466.

REINEKE, E. P., A. J. BERGMAN, and C. W. TURNER. 1941. Effect of thyroidectomy of young male goats upon certain AP hormones. *Endocrinology*, 29: 306–313.

——, J. P. MIXNER, and C. W. TURNER. 1945. Effect of graded doses of thyroxine on metabolism and thyroid weight of rats treated with thiouracil. *Endocrinology*, 36: 64–67.

Report of Third International Conference on Standardisation of Hormones. 1938. *Bull. Health Organiz., League of Nations*, 7: 887–899.

RIDDLE, O. 1931. Studies on pituitary functions. *Endocrinology*, 15: 307–314.

RILEY, G. M., A. J. STANLEY, and E. WITSCHI. 1937. The hormones of the hypophysis of the turkey. *Anat. Rec.*, 70: 1, Suppl. 1: 92.

ROGOWITSCH, N. 1889. Die Veränderungen der Hypophyse nach Entfernung der Schilddrüse. *Beitr. path. Anat.*, 4: 453–470.

Ross, R. 1938. Die Beziehungen der Schilddrüse zur Fortpflanzung. *Arch. EntwMech. Org.*, 137: 773–803.

ROWLANDS, I. W. 1936. Species variation in thyrotropic activity of the pituitary gland. *J. Physiol.*, 88: 298–304.

——, and A. S. PARKES. 1934. Quantitative study of the thyrotropic activity of anterior pituitary extracts. *Biochem. J.*, 28: 1829–1843.

SAXTON, J. A., JR., and H. S. N. GREENE. 1939. Age and sex differences in hormone content of the rabbit hypophysis. *Endocrinology*, 24: 494–502.

——, and ——. 1942. Changes in hormone content of the female rabbit hypophysis after mating. *Endocrinology*, 30: 395–398.

——, and L. LOEB. 1937. Thyroid stimulating and gonadotropic hormones of the human anterior pituitary gland at different ages and in pregnant and lactating women. *Anat. Rec.*, 69: 261–279.

SCHAEFER, W. H. 1933. Hypophysectomy and thyroidectomy of snakes. *Proc. Soc. exp. Biol. N. Y.*, 30: 1363–1365.

SCHENK, P. 1922. Über den Winterschlaf und seine Beeinflussung durch die Extrakte innersekretorischer Drüsen. *Pflüg. Arch. ges. Physiol.*, 197: 66–80.

SCHOCKAERT, J. A. 1931. Hyperplasia of thyroid and exophthalmos from treatment with anterior pituitary in young duck. *Proc. Soc. exp. Biol. N. Y.*, 29: 306–308.

SCHOOLEY, J. P. 1937. Pituitary cytology in pigeons. *Cold Spring Harbor Sympos. Quant. Biol.*, 5: 165–179.

——, and O. RIDDLE. 1938. The morphological basis of pituitary function in pigeons. *Amer. J. Anat.*, 62: 313–349.

SCHULZE, E., and G. HUNDHAUSEN. 1939a. Über die Beziehungen zwischen Schilddrüse und Hypophysenvorderlappen bei A-Avitaminose und A-Hypervitaminose. *Arch. exp. Path. Pharmak.*, 192: 43–52.

——, and ——. 1939b. Über den Einfluss der B_2-Avitaminose auf Schilddrüse, Hypophysen-Vorderlappen und Nebenniere. *Arch. exp. Path. Pharmak.*, 192: 664–669.

——, and H. LINNEMANN. 1938. Über die Beziehungen zwischen Hypophysenvorderlappen und Schilddrüse bei Skorbut. *Arch. exp. Path. Pharmak.*, 189: 448–455.

SEIDELL, A., and F. FENGER. 1914. Seasonal variation in the composition of the thyroid gland. *U. S. Pub. Health Serv. Hyg. Lab., Bull.*, 96: 67–82.

SEIDLIN, S. M. 1940. The metabolism of the thyrotrophic and gonadotrophic hormones. *Endocrinology*, 26: 696–702.

SELYE, H. 1936. The thyrotropic and adrenotropic hormones. *Proc. Ass. Res. nerv. ment. Dis.*, 17: 239–246.

SEVERINGHAUS, A. E. 1937a. Cellular changes in the anterior hypophysis with special reference to its secretory activities. *Physiol. Rev.*, 17: 556–588.

——. 1937b. Some aspects of anterior lobe function, suggested by a cytological analysis of experimentally altered glands. *Cold Spring Harbor Sympos. Quant. Biol.*, 5: 144–150.

——. 1939. Anterior hypophyseal cytology in relation to the reproductive hormones. In *Sex and Internal Secretions*, ed. E. Allen, 2nd ed., Williams & Wilkins Co., Baltimore.

——. 1942. I. Some interrelationships of the pituitary gland and the thyroid. *West. J. Surg. Obstet. Gynec.*, 50: 371–381.

——, G. K. SMELSER, and H. M. CLARK. 1934a. Ant. pituitary changes in adult male rats following thyroxin injections or thyroid feeding. *Proc. Soc. exp. Biol. N. Y.*, 31: 1125–1127.

——, ——, and ——. 1934b. Ant. pituitary changes in the adult male rat following thyroidectomy. *Proc. Soc. exp. Biol. N. Y.*, 31: 1127–1129.

——, and K. W. THOMPSON. 1939. Cytological changes induced in the hypophysis by the prolonged administration of pituitary extract. *Amer. J. Path.*, 15: 391–412.

SHUMACKER, H. B., JR., and A. LAMONT. 1935. Lack of effect of theelin upon somatogenic, thyreotropic, and adrenotropic activity of hypophysis. *Proc. Soc. exp. Biol. N. Y.*, 32: 1568–1570.

SILER, K. 1936. The cytological changes in the hypophysis cerebri of the garter snake (*Thamnophis radix*) following thyroidectomy. *J. Morph.*, 59: 603–623.

SIMPSON, M. E., and H. M. EVANS. 1941. Hormone content of pituitaries of oestrinized rats. *Anat. Rec.*, 79: 3; Suppl. 2: 57.

SINGER, E. 1936. Effects of vitamin E deficiency on the thyroid gland of the rat. *J. Physiol.*, 87: 287–290.

SKLOWER, A. 1925. Das incretorische System im Lebenscyclus der Frösche (*Rana temporaria* L.) I. Schilddrüse, Hypophyse, Thymus und Keimdrüsen. *Z. vergl. Physiol.*, 2: 474–523.

SMELSER, G. K. 1937. Assay of thyrotropic hormone on day-old chicks. *Proc. Soc. exp. Biol. N. Y.*, 37: 388–390.

——. 1938. Chick thyroid responses as a basis for thyrotropic hormone assay. *Endocrinology*, 23: 429–438.

——. 1944. Differential concentration of hormones in the central and peripheral zones of the bovine anterior pituitary gland. *Endocrinology*, 34: 39–43.

SMITH, M. G., and E. MOORE. 1933. Is ant. pituitary hormone demonstrable in urine of Graves disease, in urine of guinea pigs injected with ant. pituitary extract? *Proc. Soc. exp. Biol. N. Y.*, 30: 735–739.

SMITH, P. E. 1916. Experimental ablation of the hypophysis in the frog embryo. *Science*, N. S., 44: 280–282.

——. 1927. The disabilities caused by hypophysectomy and their repair. *J. Amer. med. Ass.*, 88: 158–161.

——. 1930. Hypophysectomy and a replacement therapy in the rat. *Amer. J. Anat.*, 45: 205–273.

——. 1931. Relations of the activity of the pituitary and thyroid glands. *Harvey Lect.*, 25: 129–143.

——, and E. C. MACDOWELL. 1930. An hereditary anterior-pituitary deficiency in the mouse. *Anat. Rec.*, 46: 249–257.

——, and I. P. SMITH. 1922. The repair and activation of the thyroid in the hypophysectomized tadpole by the parenteral administration of fresh anterior lobe of the bovine hypophysis. *J. med. Res.*, 43: 267–283.

——, and ——. 1923a. The function of the lobes of the hypophysis as indicated by replacement therapy with different portions of the ox gland. *Endocrinology*, 7: 579–591.

——, and ——. 1923b. The topographical separation in the bovine anterior hypophysis of the principle

reacting with the endocrine system from that controlling general body growth, with suggestions as to the cell types elaborating these encretions. *Anat. Rec.*, 25: 150–151.

SNELL, G. D. 1930. Effect of injection of anterior-pituitary extract on the thyroids of mice with hereditary dwarfism. *Anal. Rec.*, 47: 316.

SPAUL, E. A. 1924. Experiments on the injection of pituitary body (anterior lobe) extracts to axolotls. *Brit. J. exp. Biol.*, 2: 21–55.

——, and N. H. HOWES. 1930. The distribution of biological activity in the anterior pituitary of the ox. *J. exp. Biol.*, 7: 154–164.

SPENCE, A. W. 1937. (See A. Loeser, 1937. Hyperthyroidism and the thyrotropic hormone of the pituitary. *Brit. med. J.*, 1: 1276–1278.)

STARR, P., and R. C. BRUNER. 1935. Effect of castration on thyroid in female guinea pigs. *Proc. Soc. exp. Biol. N. Y.*, 33: 465–468.

——, and J. METCOFF. 1941. Rapid response of guinea pig thyroid to a single injection of thyrotropic hormone. *Proc. Soc. exp. Biol. N. Y.*, 46: 306–308.

——, and R. W. RAWSON. 1937. A graphic representation of thyroid response to stimulation by thyrotropic hormone. *Proc. Soc. exp. Biol. N. Y.*, 35: 603–605.

——, ——, R. E. SMALLEY, E. DOTY, and H. PATTON. 1939. The microhistometric method applied to thyrotropic hormone assay. *West. J. Surg. Obstet. Gynec.*, 47: 65–75.

——, and R. ROSKELLEY. 1940. A comparison of the effects of cold and thyrotropic hormone on the thyroid gland. *Amer. J. Physiol.*, 130: 549–556.

STEIN, K. F. 1934. Effects of avian pituitary glands in salamanders. *Proc. Soc. exp. Biol. N. Y.*, 32: 157–161.

——, and M. LISLE. 1942. The gonad-stimulating potency of the pituitary of hypothyroid young male rats. *Endocrinology*, 30: 16–24.

STEPHENS, D. J. 1940. The effect of the thyrotropic principle of the anterior pituitary on the thyroid of the undernourished guinea pig. *Endocrinology*, 26: 485–492.

STUTINSKY, F. 1936. Effets de l'éclairement continu sur la structure de la glande pituitaire de la grenouille. *C. R. Soc. Biol. Paris*, 123: 421–423.

SWINGLE, W. W. 1921. Homoplastic and heteroplastic endocrine transplants. *Anat. Rec.*, 20: 195–196.

——. 1922. Spontaneous metamorphosis of the American axolotl. *Amer. Nat.*, 56: 560–567.

TELFORD, I. R., G. A. EMERSON, and H. M. EVANS. 1938. Claim for thyroid subnormality in vitamin E-low rats. *Proc. Soc. exp. Biol. N. Y.*, 38: 623–624.

THOMPSON, K. W. 1937. Non-specificity of thyrotropic antihormone. *Proc. Soc. exp. Biol. N. Y.*, 35: 637–640.

THOMPSON, M. J. 1943. The thyrotropic potency of the anterior pituitary of castrated female albino mice as assayed in chicks. Honor Paper, Mount Holyoke College (Unpub.).

THOMPSON, W. O., and P. K. THOMPSON. 1944. The role of the pituitary in toxic goiter. *Endocrinology*, 35: 206.

THURSTON, E. W. 1933. A comparison of hypertrophic changes in thyroid caused in different species by acid extract of the anterior lobe of the bovine pituitary gland. *Arch. Path.*, 15: 67–77.

TURNER, C. W., and P. T. CUPPS. 1939. The thyrotropic hormone in the pituitary of the albino rat during growth, pregnancy and lactation. *Endocrinology*, 24: 650–655.

——, and ——. 1940. The effect of certain experimental conditions upon the thyrotropic hormone content of the albino rat. *Endocrinology*, 26: 1042–1047.

TURNER, R. S., and M. L. TURNER. 1945. The oxygen consumption and histology of the thyroid gland *in vitro*. *Endocrinology*, 36: 32–40.

UHLENHUTH, E. 1938. A quantitative approach to the secretion process of the thyroid. *Coll. Net.*, 13: 1–8.

——, K. MECH, J. U. THOMPSON, J. E. SCHENTHAL 1939. A quantitative approach to the study of the thyroid secretion process. *West. J. Surg. Obstet. Gynec.*, 47: 263–272.

——, and S. SCHWARTZBACH. 1926. Control of the thyroid function by the anterior lobe of the hypophysis. *Anat. Rec.*, 34: 119.

——, and ——. 1927. The morphology and physiology of the salamander thyroid gland. II. The anterior lobe of the hypophysis as a control mechanism of the function of the thyroid gland. *Brit. J. exp. Biol.*, 5: 1–5.

——, and ——. 1928. Anterior lobe substance, the thyroid stimulator. III. Effect of anterior lobe substance on thyroid gland. *Proc. Soc. exp. Biol. N. Y.*, 26: 152–153.

UOTILA, U. U. 1939a. Role of pituitary stalk in regulation of thyrotropic and thyroid activity. *Proc. Soc. exp. Biol. N. Y.*, 41: 106–108.

——. 1939b. The rôle of the cervical sympathetics in the regulation of thyroid and thyrotropic function. *Endocrinology*, 25: 63–70.

——. 1939c. On the rôle of the pituitary stalk in the regulation of the anterior pituitary, with special reference to the thyrotropic hormone. *Endocrinology*, 25: 605–614.

——. 1940a. The effect of estrin on the anterior pituitary of male rats after pituitary stalk section. *Endocrinology*, 26: 123–128.

——. 1940b. The regulation of thyrotropic function by thyroxin after pituitary stalk section. *Endocrinology*, 26: 129–135.

——. 1940c. Hypothalamic control of anterior pituitary function. *Ass. Res. Nerv. Ment. Dis.*, 20: 580–588.

VAN DER MEULEN, J. B. 1939. Hormonal regulation of molt and ovulation. *Proc. World's Poultry Congr. Expos.*, 7: 109–112.

VAN DYKE, H. B. 1936, 1939. *The Physiology and Pharmacology of the Pituitary Body*. Vols. 1 and 2. Univ. Chicago Press, Chicago.

VAN ECK, W. F. 1938. Sur l'action de l'hormone thyrotrope chez les souris hypophyseprives. *Acta brev. Neerland.*, 8: 180–182.

——. 1939. Sur l'action antagoniste de la thyroxine et de l'hormone thyrotrope chez les souris hypophysoprives. *Acta brev. Neerland.*, 9: 72–73.

WARBRITTON, V., and F. F. MCKENZIE. 1937. The pituitary glands of ewes in various phases of reproduction. *Univ. Mo. Res. Bull.*, 257: 1–59.

WEIGMANN, R. 1932. Jahrescyklische Veränderungen im Funktionszustand der Schilddrüse und im Stoffumsatz von *Lacerta vivipara* Jacq. *Z. wiss. Zool.*, 142: 491–509.

WHITE, A. 1944. The isolation and chemistry of anterior pituitary hormones influencing growth and metabolism. *Chemistry and Physiology of Hormones*, pp. 1–25, ed. F. R. Moulton. A. A. A. S., Washington, D. C.

WILLIAMS, R. H., A. R. WEINGLASS, G. W. BISSELL, and J. B. PETERS. 1944. Anatomical effects of thiouracil. *Endocrinology*, 34: 317–328.

WITSCHI, E., and G. M. RILEY. 1940. Quantitative studies on the hormones of human pituitaries. *Endocrinology*, 26: 565–576.

WOLF, O. M. 1934. Temperature variations and histological changes in the thyroid glands of frogs. *Anat. Rec.*, 60; Suppl. 1: 83.

WOODSIDE, G. L. 1935. The activation of the embryonic thyroid of the chick by means of thyrotropic hormone of the anterior pituitary. *Anat. Rec.*, 64: 1; Suppl. 1: 100.

ZAHL, P. A. 1935. Cytological changes in frog pituitary considered in reference to sexual periodicity. *Proc. Soc. exp. Biol. N. Y.*, 33: 56–58.

——. 1937. Cytologische Untersuchungen über die Hypophyse cerebri des weiblichen Frosches. *Z. mikr. anat. Forsch.*, 42: 303–361.

ZALESKY, M. 1935. A study of the seasonal changes in the thyroid gland of the thirteen-lined ground squirrel (*Citellus tridecemlineatus*), with particular reference to its sexual cycle. *Anat. Rec.*, 62: 109–137.

——, L. J. WELLS, M. D. OVERHOLSER, and E. T. GOMEZ. 1941. Effects of hypophysectomy and replacement therapy on the thyroid and adrenal glands of the male ground squirrel. *Endocrinology*, 28: 521–530.

ZECKWER, I. J. 1936a. Differences between castration cells and thyroidectomy cells of the pituitary of the rat in response to the administration of estrone and thyroid extract. *Amer. J. Path.*, 14: 773–782.

——. 1936b. Thyrotropic effect of pituitaries from cretin rats. *Amer. J. Physiol.*, 117: 518–524.

THE EARLY EVOLUTION OF FISHES

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VERTEBRATE paleontology is, for better or worse, a "pure" science, with as little direct application to warfare as to welfare. The years which intervened between World Wars I and II witnessed a degree of accomplishment in this field unequalled, perhaps, since the foundation of the subject by Cuvier at the opening of the nineteenth century. The recurrence of war caused the turning aside of the students of fossils to war-time activities ranging from front-line service to the prosaic teaching of army and navy student groups. This marked the end of a period. The present time is, hence, an appropriate one at which to examine some of the advances made during the two decades just past.

In no portion of the field has the advance been greater during recent decades than in our knowledge of the early evolution of the varied fish groups and the concepts in phylogeny and morphology to which this knowledge has brought us. Our ideas on these subjects have been not merely strongly modified, but in certain regards, at least, they have been completely reversed.

In the days before World War I our ideas of the relationships and evolution of the fishes seemed to be, deceptively, as stable and enduringly based as seemed the economic and political affairs of the nations of those days. The general story seemed a simple and obvious one (Fig. 1). Most primitive of living vertebrates are the cyclostomes—the lampreys and hag-fishes. These slimy and superficially eel-like creatures are surely primitive in the absence of the biting jaws which characterize all other, higher vertebrates; and nearly as primitive, we believe, is the absence of the paired appendages—fins or limbs—which are found (unless secondarily lost) in all more progressive fishes and land animals. Conceding the primitive nature of these structural lacunae, a third major feature of the cyclostomes also seemed reasonably considered as primitive—the absence of bone and the presence of a purely cartilaginous skeleton. In the embryo of any vertebrate, cartilage precedes bone in the development of most skeletal structures; the absence of bone in the adult lamprey seemed merely to confirm the impression that the ontogeny of higher vertebrates here neatly repeated phylogenetic history in the best Haeckelian style. Some features of the cyclostomes, it is true, might be considered as specializations—notably the peculiar rasping "tongue" of these predatory animals—but on the whole it was felt that a cyclostome, somewhat "toned down," was a suitable ancestor for the vertebrates.

A second stage in fish evolution appeared to be neatly exhibited by the living cartilaginous fishes —the sharks, their close relatives the skates and rays, and the more distantly related chimaeras. In these forms two major advances are seen. Well developed jaws were present, presumably formed by modified gill bars; paired fins, pectoral and pelvic, had developed as useful steering devices which were in later stages transformed into the limbs of land vertebrates. In the sharks, as in the cyclostomes, the skeleton is purely cartilaginous and bone is absent; here too this was assumed to be a primitive condition.

A final major stage in fish evolution, it was assumed, was that seen in the bony fishes, frequently termed the Osteichthyes. Here, in the major fish groups familiar to us, we find, in addition to jaws and paired fins, an ossified condition of the skeleton. Bone is present both as an internal replacement (endochondral bone) of the cartilages seen in the embryo of these fishes and the adult shark, and (as dermal bone) in the form of bony plates over the head region and bony scales of similar structure over the body. The development of bone was, as the name implies, regarded as a final achievement in fish evolution.

The subdivision of the bony fishes was by no means generally agreed upon. In general, however, good practice made a division into two groups—the Dipnoi and the Teleostomi. The former included only the three genera of tropical lungfish. These forms show a relatively low degree of ossification, suggestive, it was thought, of a rather low position in regard to the evolution of the bony skeleton. On the other hand they

were of interest in that not only the presence of lungs but various other features of their soft anatomy and embryology gave grounds for associating them with the ancestry of land vertebrates.

A grouping of the remaining bony fishes in a category of Teleostomi seemed reasonable. There were here two very unequal subdivisions. One, the Actinopterygii, or ray-finned fishes, included almost all the modern fishes with which one is ordinarily familiar—the teleosts—as well as a few more primitive living relatives. The other, the Crossopterygii, included but two living tropical forms—*Polypterus* and *Calamoichthys*—in addition to a number of fossil types. The term Teleostomi referred to a minor if useful diagnostic feature—the terminal position of the mouth opening, in contrast to the "underslung" position of the mouth opening in lungfish, which suggested a primitive, shark-like condition. More important was the fact that in almost every teleostome the skeleton was (in contrast to that of the lungfishes) highly ossified. There were, it is true, a few actinopterygians—the sturgeons (*Acipenser*) and the paddle fish (*Polyodon*) of the Mississippi—in which much cartilage was present. But these were assumed to be rather primitive forms which had not quite "made the grade." There might, it was conceded, have been some slight retrogression in skeletal evolution as regards dermal armor, for various fossil teleostomes were covered by thicker scales, shiny in appearance and termed "ganoid" by Agassiz, which are preserved today only in the gar pike (*Lepidosteus*) and *Polypterus*. But the acquisition of a well ossified skeleton was assumed to be the terminal phase of piscine evolution.

The actinopterygians, including the teleostomes, were conceded to be a terminal, but important, group of fishes. These eminently successful forms are characterized by numerous features contrasting with those of both crossopterygians and lungfish; notably these include the practical absence of a flesh-and-bone fin lobe, and the development, instead, of a ray-supported fin (to which the group name refers); dominance of sight over smell as the most important of the senses; development of an air-bladder.

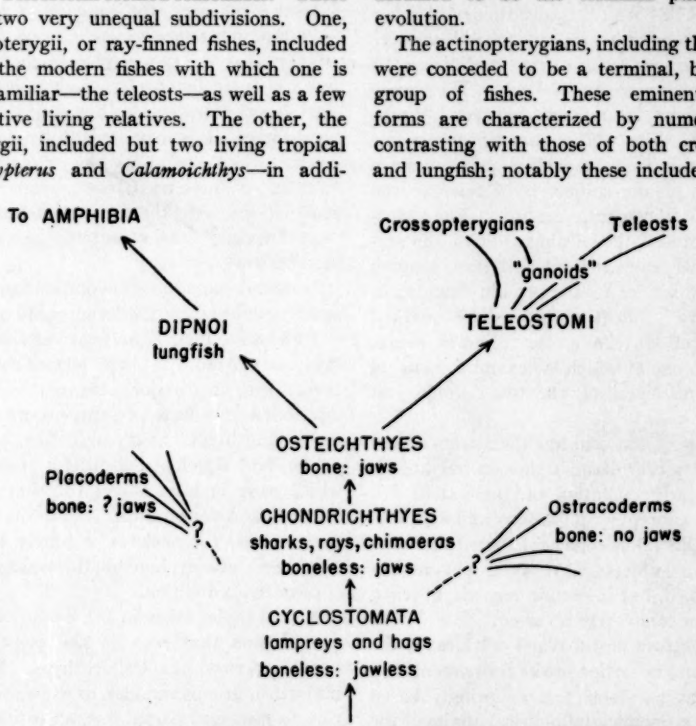

FIG. 1. A FAMILY TREE SHOWING CONCEPTS OF FISH PHYLOGENY GENERALLY HELD IN THE EARLIER YEARS OF THE CENTURY

The evolutionary position of the Crossopterygii was in debate. This group, established by Huxley, showed, particularly among the fossil genera, characters making it possible to consider them as ancestors of land vertebrates. Even in the two living genera assigned to the group there were suggestive features: a rather fleshy lobe to the fins, absent in the typical ray-finned Actinopterygii; and, more important, the presence in *Polypterus* of paired ventral lungs comparable to those

in tetrapods (and lungfishes) rather than the single dorsal air-bladder of the teleosts—a structure from which it was rather generally assumed that the lung had been derived. But in other anatomical features, and in its embryology as well, the living representative, *Polypterus*, was far less comparable to tetrapods than were the lungfish; crossopterygian ancestry of land vertebrates seemed very doubtful.

What of the fossil record? Hundreds of fossil types had been discovered, many of them as far back as the time of publication of Agassiz's great work, *Les poissons fossiles*, which founded paleoichthyology a century ago. Most, however, were known in but superficial fashion. Great numbers were obviously related to the existing teleosts, and many more were "ganoids," presumably early teleostomes of some sort. A few others were definitely fossil lungfishes; many were definitely sharks or rays. There remained, however, a large number of Paleozoic fossils, many of them grotesque and varied bony armored types, large and small, which did not fit well into the general evolutionary picture nor into any familiar group. Such types were the varied ostracoderms and placoderms. To deal with such problematica was a problem indeed. A common solution was to ignore them. Even in such a standard (and still very useful) work as that of Goodrich (1909), they were in general treated rather as appendages to the recognized groups, as undesirable excrescences on an otherwise well-rounded evolutionary structure.

This, then, was the general nature of our concepts of fish relationships and evolution as held in the early decades of the present century. These concepts seemed firmly established—as did many things in the world in those days. But just as our ideas of world politics and economics were due for a major upheaval and readjustment, so were our ideas in this particular area of scientific thought. The evolutionary story is not the simple one which we had believed; and much of it was, it would seem, quite erroneous.

We may well begin a consideration of the newer developments in paleoichthyology by a discussion of Stensiö's monograph on the Spitzbergen cephalaspids (1927), since this publication had a major influence on later work on fossil fishes, and since this author has played a leading role in this field. (On cephalaspids, see also Stensiö, 1932b; Heintz, 1939; Robertson, 1935a, 1935b, 1938.) The cephalaspids (Fig. 2) belong to a general category of fossil fishes called ostracoderms (the word is not properly usable in a taxonomic sense), which were the most conspicuous types of vertebrates in the oldest stages of known fish history—the late Silurian and the Devonian. They were peculiar forms of modest size (usually but a few inches to a foot or so in length) which did not fit well into any recognized group. What evidence was available concerning them indicated the probable absence of jaws or of typical paired fins. But they were obviously most uncyclostome like in the fact that they were covered by stout bony armor—a feature to which the name ostracoderm ("shell-skinned") refers. Bone, as we have noted, should not be present on the main line of vertebrate evolution at such an early stage, according to orthodox beliefs. Hence, if not ignored, the ostracoderms were generally regarded as a sterile side-branch of the early fishes which had prematurely acquired a bony shell but had disappeared, without advantage to vertebrate posterity, at an early date.

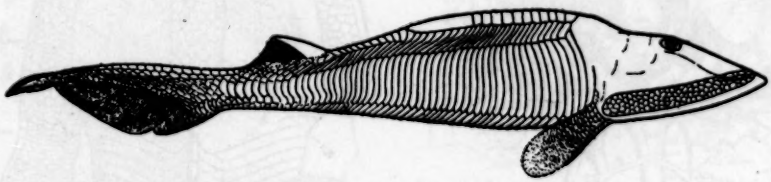

FIG. 2. SIDE VIEW OF A CEPHALASPID OSTRACODERM, *HEMICYCLASPIS* (After Stensiö)

Most early students of ostracoderms had contented themselves with a brief description of such superficial features as could be readily discerned; once given a name, little more was done. Stensiö's work was vastly different in nature; by the use of various chemical and physical means and new or difficult techniques, he attempted to extract the maximum of data available as to the structure

of these animals, and to apply these data to the solution of morphological and phylogenetic problems. Most of the material consisted of head shields, often no larger than a postage stamp. Stensiö discovered that internal structures were well preserved, and he "dissected" various specimens with needles under binoculars, with excellent results. Others were serial-sectioned.

Sollas (1903) had invented a method whereby fossil specimens might be embedded in blocks of plaster or other hard material and gradually ground down, by fractions of a millimeter. After each grinding the surface of the block was drawn or photographed. When the grinding was completed, the specimen was completely destroyed, but a record of successive sections had been preserved, from which, as from serial sections of an embryo, wax-plate reconstructions could be made at any desired magnification.

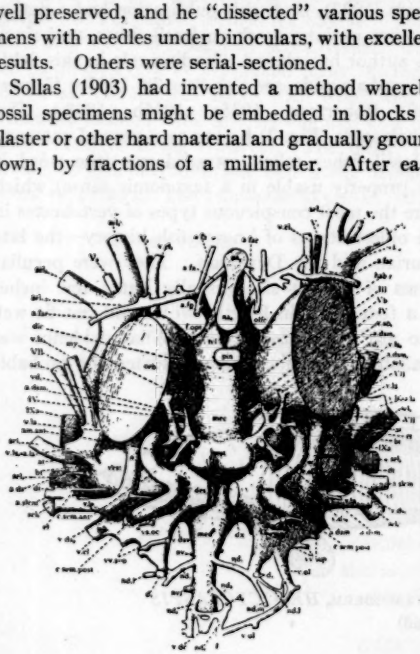

FIG. 3. A SAMPLE OF THE DETAILS OF ENDOCRANIAL STRUCTURE FOUND IN CEPHALASPIDS BY SERIAL SECTION METHODS

The area includes the brain, orbits, internal ear region and associated blood-vessels and nerves; about 20 times the size of the original. (From Stensiö).

This method has the disadvantage that in case of doubt, appeal from the drawing or photograph to the original is impossible, since the surface pictured is destroyed by the next grinding. The writer (Romer, 1936b, p. 88) has here introduced an improvement by adapting to vertebrate material the "peel" method long familiar to the paleobotanists. It was found that in the case of vertebrate material, etching with acid softens a thin layer of all materials present; this layer is removed with the dried cellulose acetate peel as a permanent record. The method has since been applied to a variety of invertebrate materials as well.

Figure 3 gives some idea of the wealth of structural detail rendered possible by this technique. As a result of Stensiö's work we now know more of the cranial anatomy of the cephalaspids than of many living groups of vertebrates.

The cephalaspid "head" (Fig. 4), flattened beneath but arched above, has a somewhat crescentic outline, generally produced into "horns" at the posterior corners. The dorsal surface was covered by a solid carapace of bone, broken at only a few places. A pair of circular openings were obviously orbits; a smaller perforation between them was reasonably interpreted as for a pineal eye. More uncertain in nature were a more anterior median slit-like opening and three areas—one medial and a lateral pair—floored by a pavement of small polygonal plates. Ventrally (Fig. 5) the "throat" was occupied by a seeming rather loose and irregular series of plates; anteriorly a small slit was obviously a mouth; on

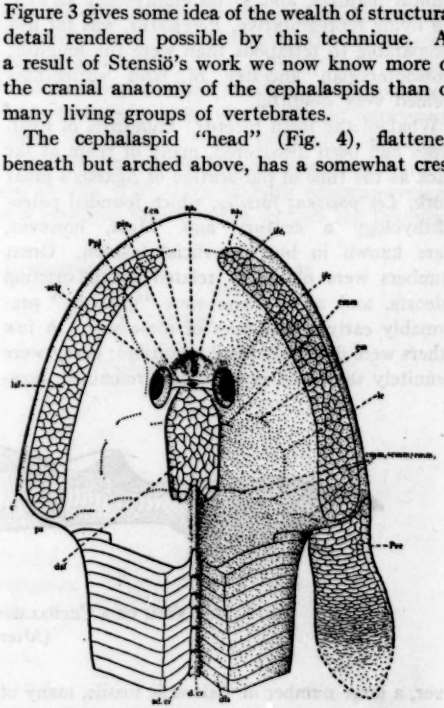

FIG. 4. DORSAL SURFACE OF THE HEAD SHIELD OF A CEPHALASPID

Openings are shown for the paired and median eyes, and the nasal-hypophysial pocket. Three "tesselated" areas are those presumably occupied by electric organs. The pectoral "paddle" is shown on the right. (From Stensiö).

either side a series of small round holes were reasonably regarded as gill openings.

We have noted that the presence of bone of any sort in early or primitive vertebrates was repugnant on theoretical grounds. The presence of bone in the early ostracoderms could not be denied; but some "face" was saved by the assumption that the bone was only skin-deep in the ostracoderms—purely dermal in nature—and that deeper bone, replacing embryonic cartilages, developed only in the higher bony fishes. In some ostracoderms, it is true, we have as yet failed to find internal ossifications. But in the cephalaspids there is, beneath the shield, an endocranial structure in which a high degree of perichondral ossification was present and sometimes true endochondral ossification as well. Stensiö has described a complicated series of cavities and passages in the endocranium which enabled him to give a comprehensive account of the neurology and angiology of the head region (Fig. 6).

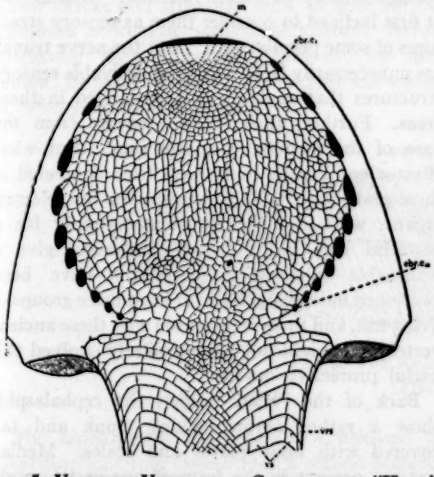

FIG. 5. VENTRAL VIEW OF A CEPHALASPID "HEAD"
The mouth (*m*) is a small ventral slit; lateral openings are those of the gill pouches. (From Stensiö).

A large centrally situated longitudinal cavity contained the brain; its contours indicate a rather cyclostome-like structure for this organ. Anteriorly the brain cavity was in connection with a cavity beneath the slit-like opening seen on the upper surface. The topography makes us conclude that this organ was a dorsal single nostril and hypophysial opening, constructed exactly as in modern lampreys and in sharp contrast to all other vertebrates except the related hagfishes. These cyclostome features in animals so unlike lampreys superficially are surprising; but the ear region furnishes another indication of relationship. Whereas all other vertebrates have three semicircular canals, the lampreys have but two, and the hagfishes one. Two canals, and two only, are present in cephalaspids.

Dissection revealed the fact that almost the entire under surface (Fig. 7) was occupied by a series of large gill pouches. There were nine or ten pairs of these structures. In higher fishes there are typically but six pairs of gill openings, including the spiracle; but since existing cyclostomes have from 8 to 14 pairs of gill pouches, the cephalaspid number is one to be reasonably expected in a primitive vertebrate. At the front, the small jawless mouth cavity was merely an unimportant vestibule to the pharyngeal region.

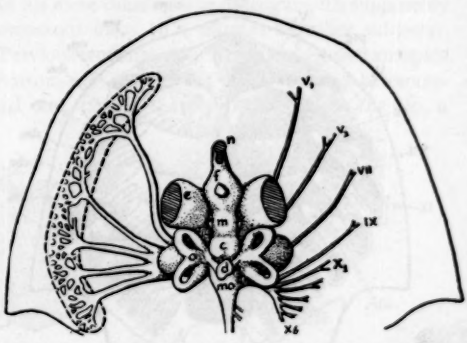

FIG. 6. SIMPLIFIED DIAGRAM OF MAJOR CAVITIES IN THE ENDOCRANIUM OF A CEPHALASPID
In the mid-line are seen the nasal-pituitary pouch area (*n*), followed by the brain cavity (*f*, *m*, *c*, *mo*). On either side is the orbit (*e*), and the cavities of the internal ear (*o*). On the left are the nerves to the lateral electric field of that side; (*d*) is a similar nerve to the dorsal electric field; on the right are nerves of the V–VII–IX–X system, "segmentally" arranged in relation to successive gill pouches. (Data from Stensiö).

In higher fishes and tetrapods the cartilaginous or bony bars which lie between the gill slits are generally independent elements, free of attachment to the braincase or other cranial structures, and most theories of vertebrate evolution assume that this condition was a primitive one. But in the lamprey the gill bars are united into a continuous basket which in turn is in contact with the braincase; and in cephalaspids, the braincase and

the gill structures preserved are solidly and inseparably fused into a united head structure unequalled in its extent of ossification in any other vertebrates—the "skull" includes the entire area back to and including the shoulder region. Quite possibly our idea that the various elements of the skeleton in this area were originally discrete is an erroneous one, and it may be that the separate structures seen in later types are due to disintegration of an originally solid mass (Romer, 1937).

In higher fishes we find that each gill slit has associated with it a specific cranial nerve, the main trunk of which passes down the septum pos-

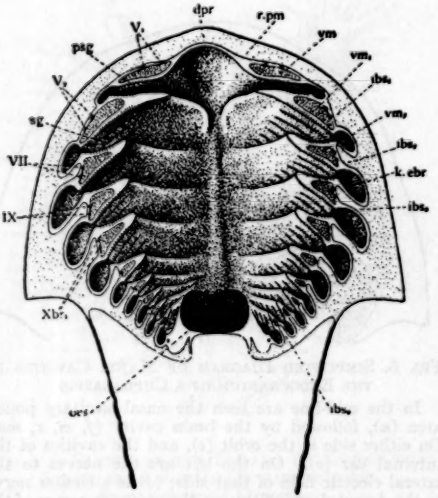

FIG. 7. THE PALATAL ASPECT OF THE HEAD OF A CEPHALASPID, WITH THE GILLS RESTORED
(From Stensiö)

terior to its proper opening. Thus the seventh nerve is associated with the spiracle; the ninth with the first typical gill slit; the tenth, by successive branches, supplies the remaining gills. Anteriorly the fifth (trigeminus) nerve passes down behind the mouth, seemingly completing the series. But although the ophthalmicus profundus is in adult mammals associated intimately with the trigeminus and therefore counted as part of that nerve, its embryology and structure long ago led morphologists to believe that it was originally a separate nerve, supplying a gill pouch lost with the enlargement of the jawed mouth. *Cephalaspis* abundantly proves the truth of this hypothesis. As may be seen from Figure 6, the profundus (V_1) is a well developed and distinct nerve, serially preceding the trigeminus proper ($V_{2,3}$) and supplying its own proper gill. A check on its position reveals a further interesting fact—namely, that not one but two gill pouches present in cephalaspids have been lost in the higher vertebrates; for the homologue of the spiracle, the first of the pouches in sharks or bony fishes, can be definitely identified as the third in the *Cephalaspis* series (Westoll, 1937c).

From either side of the brain cavity in the medullary region, tubes for very stout nerve trunks pass out to enter the plate areas noted on the surface. Obviously these areas had some important sensory or motor function. Stensiö was at first inclined to consider them as sensory structures of some peculiar sort. But the nerve trunks are unnecessarily large for any conceivable sensory structures that could have been lodged in these areas. Further, these trunks emerge from the base of the medulla, a motor area. But what effector end organs could have been concealed in these plate areas? As Stensiö points out, electric organs, with an abundant nerve supply for a powerful and instantaneous discharge, give a reasonable solution. Such organs have been developed independently in at least three groups of living fish, and there is no reason why these ancient vertebrates might not have similarly evolved this useful protective device.

Back of the "head" region the cephalaspids show a rather normal-looking trunk and tail covered with bony plates and scales. Median fins are present in the form of one or two scaly dorsals and a caudal. Normal paired pectoral and pelvic fins such as are seen in sharks or higher bony fishes are absent, as is the case in cyclostomes. There are, however, structures which may be more or less homologous with such fins. The trunk, anteriorly, at least, is more or less triangular in section, with a flat belly as its base and a median dorsal apex. At either lateral angle there is a row of prominently projecting scales which undoubtedly served as stabilizers to prevent rolling. They are thus at least analogous in function as well as similar in position to paired fins. Of greater interest is the presence, in many cephalaspids, of scale-covered flaps or paddles which developed back of the "horns" on the cephalic shield. These curious outgrowths (the internal anatomy is unknown) obviously served a function similar to that of the pectoral fins of higher fishes;

and Stensiö points out that the "horns," situated behind the gill region, are reasonably regarded as pectoral girdle structures. If, however, these paddles are interpreted as pectoral fins, it may be noted that they have developed independently of such fins in other vertebrates (Westoll, 1942); for some of the oldest and most primitive cephalaspids of the Silurian lack the horn expansion and the bay back of it in which the paddle was later developed.

These once obscure ostracoderms, the cephalaspids, are now seen to be a primitive but highly complex type of organism, with interesting indications of relationships to the cyclostomes. Their nature and structure tend to raise various problems concerning vertebrate history. Before discussing these questions, however, we may review, in briefer fashion, our current knowledge of other ostracoderm groups.

as in sharks, and early restorations of anaspids figured these little fishes in that position. The late Otto Jaekel of Greifswald disputed this, and claimed that the tilt was downward. This, however, seemed improbable; Jaekel was a "wild man," with wild ideas, and his suggestion was ignored.

The late Silurian (Downtonian) of southern Norway was found to contain much better specimens of anaspids than the Scottish material; these were described by Kiaer in 1924. One feature clearly demonstrated was that of proper body orientation; Jaekel's idea on this subject proved to be right (as have, most embarrassingly to his more conservative colleagues, his supposedly erroneous ideas on a number of other subjects). Previous students of the group had figured anaspids bottom-side-up; the tail was a reversed heterocercal one, turned sharply downward at the tip, a

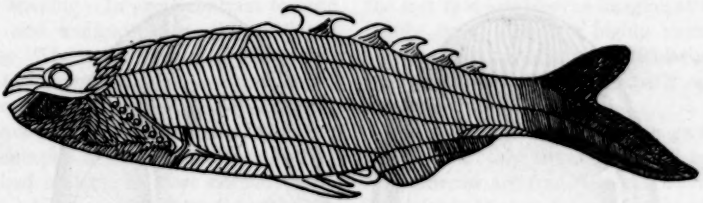

FIG. 8. THE ANASPID *BIRKENIA*
(From Stetson)

The cephalaspids are generally considered to constitute an Order Osteostraci; a second ostracoderm order, quite different in appearance, but now known to be rather closely related, is that of the Anaspida (Fig. 8). Except for two stragglers in the late Devonian, all known anaspids come from Silurian deposits. They were first described by Traquair (1899, cf. Stetson, 1928) half a century ago, on the basis of remains from Scotland. The typical anaspids were tiny fishes, only a few inches in length. The body was covered with relatively large scales of bone-like material (Gross, 1938a); in contrast to the cephalaspids, internal skeletal structures are as yet undiscovered. In the original specimens the head region was badly crushed, so that little could be determined of the topography here. The body was of a seemingly rather normal fish-like appearance; no paired fins were present, but there were median fins and highly developed spiny structures. The tail was of the sharply tilted heterocercal type seen in sharks. It was assumed that the tilt was upward

feature giving rise to interesting speculations as to the mode of life and swimming habits of these forms. A set of median spines which had previously been shown as projecting downward, now are seen to rise up from the dorsal peak of the body as useful protective devices. Along the flanks other paired spines are somewhat suggestive of incipient paired fins. These forms, in contrast to the rather flattened and seemingly sluggish cephalaspids, apparently possessed well-rounded and perhaps even somewhat compressed bodies, and hence may have been much more active swimming types.

The surface anatomy of the head region is well displayed. The mouth opening was a much elongated slit, although it is believed that jaws were not developed. The head is covered by armor, but this takes the form of small oat-shaped scales or plates, rather than the compact shield of the cephalaspids. Despite the contrast with that group in various features already mentioned, there are strong indications that anaspids are closely

related to the cephalaspids. Atop the head, the anaspids bear a series of openings exactly comparable to those of cephalaspids; a pair of orbits with a pineal opening between them and, in front, the characteristic opening of a single nostril-hypophysis in cyclostome-cephalaspid fashion. A further similarity to cephalaspids and lampreys is the fact that down along the sides of the pharyngeal region there is a slanting row of circular holes—obviously the openings from the gill pouches the latter—we have ostracoderm groups which show, despite superficial differences, great similarities to the cyclostomes and seem surely related to them in some fashion. A third major group of Silurian and Devonian ostracoderms, the Heterostraci, is very different in nature (Figs. 9, 10). Kiaer and Heintz of Oslo have been prominent workers on these forms (Kiaer, 1932a, Kiaer and Heintz, 1935; see also Bryant, 1933–34, 1935; Brotzen, 1936); White (1935) has contributed an

FIG. 9. THE HETEROSTRACAN *PORASPIS*
(From Heintz)

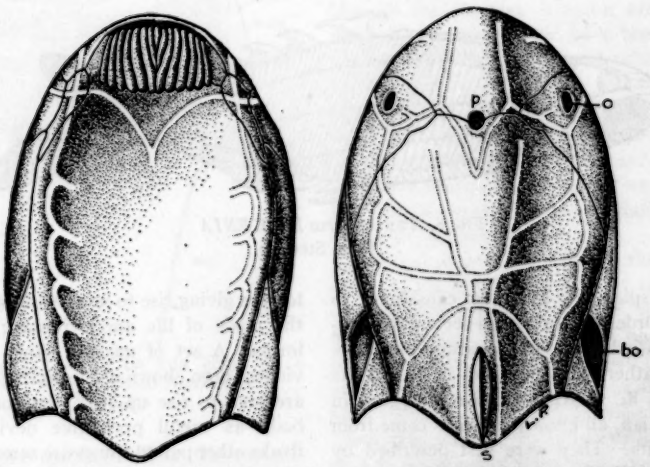

FIG. 10. VENTRAL AND DORSAL VIEWS OF THE SHIELD OF THE HETEROSTRACAN *PTERASPIS*
p, pineal opening; *o*, orbit; *bo*, branchial opening. (Redrawn from Kiaer).

which, as in the other groups mentioned, opened separately to the exterior.

The anaspids just described are the more typical members of the group. There were, however, variants. *Lasanius* of the Silurian, for example, lacked much of the dermal covering (Bulman, 1930); *Endeiolepis*, recently described by Stensiö (1939a) from the upper Devonian of Scaumenac Bay in Canada, appears to have been approaching a soft-bodied condition, and had seemingly developed fin membranes in place of lateral spine series.

In the cephalaspids and anaspids—particularly account of *Pteraspis*, a prominent member of the group.

In the Heterostraci we find, as in the two groups already discussed, a fish-like, scale-covered body, with a reversed heterocercal tail comparable to that of the anaspids. The head and gill region was encased solidly in bony plates. So far, there is a general comparison with the cephalaspids. But in cranial anatomy we have a group very dissimilar indeed to both cephalaspids and anaspids.

There are no preserved remains of internal structures, and our knowledge of the head region

(Fig. 10) is confined to superficial topography and impressions of structures on the inner surface of the dermal plates. Basically the head shield was built of two essentially oval plates, covering dorsal and ventral surfaces. In earlier and more primitive genera these two major plates are thick and solid units; in later genera the shields are thin, and each may be subdivided into several elements. In late and specialized forms, particularly *Pteraspis*, there may be a projecting rostrum; in others this is absent, and the mouth is a nearly terminal transverse slit between dorsal and ventral shields. Obviously there were no jaws in connection with this opening; below it, however, there may be found a number of small movable plates, suggesting that some type of nibbling movements may have been possible. Eye sockets are represented by a pair of small openings situated (in contrast with cephalaspids) far to the sides; in some forms (but not in all) there was a pineal opening. In great contrast to both cephalaspids and anaspids, there is no dorsal nasal opening. The under surface of the rostral part of the shield sometimes shows a pair of depressions, near either margin of the mouth opening, which may have been occupied by nasal capsules; if this interpretation is correct, the Heterostraci possessed paired nostrils, in more normal vertebrate fashion. As is proved by impressions on the inner surface of the dorsal shield, the cephalic armor included the pharyngeal region as well; much of the interior was occupied by paired gill pouches. Unlike the cephalaspids and anaspids, however, the gills did not open individually to the exterior; instead they converged into a single external opening far back along the flank.

In addition to the typical heterostracans just described, the order includes various other forms, such as the depressed *Drepanaspis*, *Psammosteus* and their relatives (Gross, 1930, 1933b; Obruchev, 1943a, 1943b). Allied to the Heterostraci, if not members of this order, are the poorly known coelolepids (Kiaer, 1932b), in which the structures of the head are poorly known; this region was covered, not by large plates as in the typical heterostracans, but by scales similar to those covering the body.

The three groups here reviewed are the "ostracoderm" orders. They are the oldest of known vertebrates; fragments of them appear in the Ordovician rocks; they are the only adequately known vertebrates in the Silurian. In the early Devonian they still flourished, but other, higher vertebrates had already put in an appearance; by the end of that period they had vanished. The ostracoderms are surely primitive in the absence of jaws; in that respect they are on the same structural level as the cyclostomes, and should be grouped with them. It is generally accepted at present that the cyclostomes and ostracoderms constitute a basal class of the vertebrates, the Agnatha (jawless vertebrates). The ostracoderms are thus in certain regards primitive backboned animals, and the Agnatha by definition include the basic vertebrate stock.

We may pause here to consider some of the many problems raised by the ostracoderms and to which our knowledge of the group contributes evidence.

Are any of the ostracoderms the actual ancestors of the later vertebrates? Our minds shrink from the thought, for they are not simple, diagrammatic "generalized" ancestral types of the sort that one likes to imagine at the base of a family tree. They are highly varied; they are complex in structure (as particularly seen in the cephalaspids) and all are greatly specialized in numerous particulars.

The geological story seems to give us an easy "out" from this situation. The better known ostracoderms are from the late Silurian and the Devonian. We know, however, from fragmentary evidence that the ostracoderms were in existence in the Ordovician, some 50,000,000 years or more before, and they may have been in existence still earlier. We are not looking, then, at primitive ostracoderms, but forms living at the close of a long and almost unknown first cycle of vertebrate evolution. At some earlier time there may have lived more generalized types from which the later vertebrate groups may have taken origin.

But one should not cling too eagerly to such a means of escape. The human mind tends to generalize and simplify. In animal evolution we constantly assume the derivation of "specialized" and complexly built forms from simple "generalized" ancestors. But no one has ever found a diagrammatically generalized ancestor lodged in other family tree-trunks; should we expect to find one here, no matter how much knowledge the future brings us of ostracoderm ancestry? An animal cannot, after all, spend its time being a diagrammatic ancestor. It must make a living, eat, escape enemies, reproduce. To live, it must be adapted to its environment. Such adaptations are in themselves specializations. The evolution

of an animal group is not in general from simplicity to complexity, but from one complexly specialized condition to another.

We frequently speak of the "irreversibility of evolution," and sometimes dignify this thesis with the term "law." It is true that evolution never turns directly back on itself and that structures once lost are never regained in their original form. But if, as is often done, we assume that this "law" implies that specializations once attained are never shed, we are denying the truth of much hard earned knowledge regarding actual evolutionary lines.

What is a "specialized" animal? Our general conception is that of a form which has acquired such a collection of peculiar structures and habits that it is off any main evolutionary track, and is headed for extinction; it is the "generalized" animal, we say, which is successful, can adapt itself to changing conditions and give rise to later forms. But how do we tell one from the other? The answer is an embarrassingly simple one. Why were the great dinosaurs and the dodo "specialized"? Because they did not survive to give rise to descendants. A "generalized" animal is one that is successful; a "specialized" form is one that became extinct. The proof of the pudding is the eating.

What do the ostracoderms tell us of the invertebrate ancestry of the vertebrates? Very little, directly. For one thing, as we have noted, the known ostracoderms are far removed in time, and perhaps in structure, from the earliest vertebrates. There is no evidence suggesting any relationship to the annelids along the lines of the classic Dohrn-Semper hypothesis. Nor, despite the presence of a superficial "shell" is there any real substantiation of the arachnid theory ardently advocated by Patten (1912, etc.).

On the other hand, the high degree of development of the gill system is suggestive of a derivation of the early vertebrates from lower chordate types allied to *Amphioxus*, the tunicates, and the balanoglossid "worms." As we have noted for both cephalaspids and pteraspids, the gill system is very highly developed. It occupies the greater part of the enlarged "cephalic" region as a series of large and numerous paired pouches.

One tends to gain a conception that a typical ostracoderm was an animal made up of two more or less discrete components: an enormous pharyngeal pouch apparatus on the one hand; and on the other, a locomotor tail, furnished with musculature to transport the gill-system from place to place, and with a nervous system and sense organs to aid in this transport.

This concept is, of course, an exaggeration. But the study of vertebrate anatomy and embryology strongly indicates that the pharyngeal system is a thing apart from the rest of the vertebrate body. The gill cartilages are formed (from neural crest material) in a fashion quite distinct from that seen in other parts of the skeletal system; the striated visceral muscles are hypomere derivatives, in contrast to the typically myomeric origin of "normal" striated musculature; these visceral muscles are innervated by a special series of cranial nerves (V, VII, IX, X) quite in contrast with the innervation of other striated muscles by somatic motor roots or cranial nerves corresponding to them. All in all, the branchial apparatus is *sui generis*. Small in higher vertebrates, it is important in lower types and is seen in its maximum vertebrate development in the ostracoderms.

The Phylum Chordata, to which the vertebrates belong, is named and often defined on the basis of the presence of a notochord. Actually, however, the presence of a gill system is a much firmer bond of union. In the tunicates the notochord is seldom present in the adult, often absent even in development; in the balanoglossids the presence of a notochord is more than doubtful, but typical gills are present. The pharynx is highly developed in all these lower chordates. And in the tunicates we come close to the realization of the concept of a dual organism noted above. In the typical solitary tunicate, the embryo consists of a large developing pharyngeal basket, to which is appended a muscular tail, with appropriate sensory and nervous structures, which transports the basket to a spot appropriate for its future existence. Once arrived, the locomotor component of this dual personality is resorbed and vanishes; only the pharyngeal component survives.

The reason for the large size and complex structure of the pharynx in the early verebrates is obvious, once the mode of life is considered. In higher fishes the major, and usually the sole function of the gill apparatus is that of breathing, and we tend, unthinkingly, to take it for granted that this was its primary reason for existence. But in lower chordates this is not the case. As we see it best developed in tunicates, it is obvious that its major function, appropriate to its position at the beginning of the digestive tract, is one of food-collecting. The tunicate (or *Amphioxus*)

has no other food-gathering device than that of passing a water current through its gill system and straining off from the passing stream food particles for its nutriment. Except (curiously) for certain large sharks and whales, which appear to have secondarily reverted to it, no adult living vertebrate is a food-strainer; jaws, or, in the case of the modern cyclostomes, a specialized rasping "tongue" are used to gather food materials, and the original pharyngeal function has been abandoned.

The early ostracoderms, however, had neither good vertebrate jaws nor the specialized cyclostome "tongue." Their only food-gathering device must in general have been that of their lower chordate ancestors and of larval lampreys today—the passing of volumes of water through the gills and the filtering off of food materials. It is for this reason that we find a great development of the gill pouches in early vertebrates.

With these food habits may also be reasonably associated the development of the flat depressed body and seemingly sluggish locomotor habits seen in cephalaspids and the Heterostraci (although not in the anaspids). The major food supply lay in the rich bottom of the water bodies which these animals inhabited, and there was presumably a strong trend toward a bottom-dwelling existence. And, further, the frequent occurrence of a conspicuous "pineal" eye in early vertebrates may be associated with these habits. For a bottom dweller, most of the things to be seen were above him, and a dorsally directed eye would be of great utility. With a more active life, the usefulness of such a structure would be greatly decreased, and most progressive fishes, beyond the Devonian, abandoned a functional median eye.

A problem that these old ostracoderms throw in our faces is that concerning the nature of the primitive vertebrate skeleton. As was said earlier, we were taught that the original vertebrate should have been a cartilaginous fish; bone should appear only in advanced fish types. But here are the oldest known vertebrates; and they are in great measure bony forms. How can we account for this fact? If we wish to cling to the evolutionary faiths of our scientific fathers, we must assume that the ostracoderms are not the actual vertebrate ancestors, but a side branch in which bone has developed independently. This, of course, makes it necessary to believe that bone has been "invented" twice in the vertebrate series, once in the ostracoderms and a second time subsequent to the evolution of jawed cartilaginous forms of shark-like types. This is possible, for parallelism is a common phenomenon in vertebrates. It is further necessary to believe that there existed, contemporary with the ostracoderms, cartilaginous forms which gave rise to more advanced fish types; such forms, we must assume, have escaped preservation because of their lack of hard parts. This is, again, possible (although in later ages we do frequently find cartilaginous fishes in fossil deposits).

But the difficulties of the "fundamentalist" position on skeletal history do not cease here. Since certain ostracoderms (Osteostraci, Anaspida) are apparently closely related to the lampreys, while other ostracoderms (Heterostraci) show no evidence of affinity to any of the cyclostomes, it is necessary to assume that bone appeared several times independently among the varied ostracoderms. Further, the difficulties are not over when we progress beyond the ostracoderm stage into that of jawed vertebrates, for, as we shall see, there are many jawed forms, lower than the sharks and far earlier in appearance, which were already bony types. Still further, we shall see that higher bony fishes are themselves older than the sharks, who are, in fact, the last major group of fishes to appear in the geologic record.

We may still cling forlornly to the frail hypothesis of unknown non-bony ancestors to connect all these forms if we will. But still another type of evidence is present which argues strongly against the supposed primitiveness of cartilage. If our earliest fishes are forms in which bone had just been acquired, we would expect that the succession of forms in each group, from earlier to later, would show an increase in the amount of bone present. This is, however, not the case. Among Paleozoic vertebrates there are a few groups (highly successful, it is true) in which the degree of ossification seen in their earliest members is preserved; such forms are the ancestors of the modern teleost fishes and the early reptiles. But in almost every other case the phylogenetic history shows, as time goes on, not an increase in ossification, but a reduction. This will be found to be true, among higher fishes, in the case of both lungfishes and crossopterygians. In most actinopterygians there has been reduction in the exoskeleton, and living survivors of the lower levels of that group (sturgeon, paddle-fish), have lost most internal ossification as well. Among the placoderms which we shall presently consider, the later members of two

major groups are much less thoroughly ossified than the earlier ones. And—returning to the ostracoderms—Stensiö and Heintz, major workers on cephalaspids and pteraspids respectively, note emphatically that in the Devonian forms the ossification is much reduced from the earlier Silurian condition; the once stout armor becomes paper-thin.

Thus, throughout the fishes, the general trend in known times has been away from bone, not toward it; not increasing ossification but skeletal degeneration. It is highly improbable that there occurred at this early date such a sharp reversal in evolutionary trend as would be required under the assumption that vertebrates, having up to a certain point been engaged in acquiring bone, suddenly did an about face and almost unanimously set about reducing this newly won skeleton.

The facts stated above do not prove that the earliest vertebrates were well-ossified animals. But they do cast almost insuperable doubts upon the opposite belief that the early vertebrates were cartilaginous. As a working hypothesis, the belief that the early vertebrates were well ossified, first suggested by Jaekel and clearly enunciated by Stensiö in 1927, fits the known facts much better.

If the primitive vertebrate skeleton was a bony structure, why the presence of cartilage in the embryo? I have recently discussed this question (Romer, 1942). It will be noted that cartilage is never present in connection with superficial, dermal bones with simple relationships and simple growth; it is present only in internal bones which are of complicated structure and have intimate relations with other bones, blood-vessels, muscles and nerves—relations which are established at an early embryonic stage and must be maintained during growth. Bone cannot expand and can grow only by superficial accretion, a process which would, during the great growth necessary from embryo to adult, continuously disrupt the connections between the bone and associated structures. A cartilage, on the other hand, has the power of expansion and is able to increase in size without disturbing surface relationships. It is therefore an ideal material in which to form the embryonic model of an adult skeletal element. Cartilage may thus be regarded as a vertebrate skeletal material as old as bone, perhaps, but one introduced as an embryonic adaptation; the presence of cartilage in an adult is to be regarded as a degenerate condition, diagnostic of neotenous tendencies.

We have noted that the vertebrates are first seen clearly in the late Silurian, as full-fledged, "specialized" and diversified ostracoderms. They had obviously had a long earlier history before arriving at this stage; but of this history we know nothing except for bone fragments from one Ordovician formation (Bryant, 1936). In the lower Paleozoic, invertebrate fossils of varied types are abundant down to the lower Cambrian, some 150,000,000 years or so before the Silurian emergence of the ostracoderms. Vertebrates must have been in existence, or in process of evolution, during most of this time. Why do we not find them as fossils?

The answer may perhaps be found in a consideration of their environmental history. Most primitive animals (and plants) live in the sea; the lower chordates are exclusively marine; the vast majority of living fishes are likewise salt-water forms. It is therefore only natural that many have assumed that the ancestral vertebrates lived in a marine environment.

Doubts, however, have long been prevalent concerning this thesis. The structure of the generalized vertebrate kidney tubule is, as Homer Smith has pointed out (1932, etc.), one which seems adapted for life in a fresh water environment, not the sea; Chamberlin (1900) suggested that the fusiform shape and activity of fishes may well have arisen in connection with life in stream currents. Paleontologists have been of two minds regarding the matter; vertebrates were certainly in both fresh and salt waters at an early date, and no general study of the evidence was available. The writer had favored moderately the fresh-water theory of origin; some years ago he associated himself with an invertebrate paleontologist whose sympathies were initially on the other side of the question, in an attempt to summarize a considerable body of the available evidence and try to reach some satisfactory conclusion in as objective a manner as possible (Romer and Grove, 1935).

It was decided to assemble all known data on American vertebrates earlier than the Carboniferous and from this to determine, as far as possible, the environments in which these fossils were present. The geographical limitations were made because of lack of detailed familiarity with European deposits; the time limit was set, because by

the Carboniferous there were certainly numerous fishes in both fresh and salt waters. Within these limits hundreds of finds of fossil fishes had been made, and the "sample" seemed a reasonably representative one.

The fishes so studied belonged, then, to the Devonian and the later part of the preceding Silurian period. In late Devonian times the known fishes were almost all clearly sortable into two distinct faunas. One occurred in deposits which seemed definitely marine, with numerous associated salt-water invertebrates, etc. The other fauna, occurring in sediments in which evidences of marine life were usually lacking, seemed certainly fresh-water in provenance.

In earlier Devonian strata, marine finds are, in contrast, rare; almost all discoveries have been made in rocks which appear to have been laid down in streams or, at the most, in their estuaries. And in the Silurian the American finds are exclusively in sediments of non-marine nature.

It seems reasonable to conclude, then, that the vertebrates began their existence as an inland group and that only later did they re-enter the seas that their chordate ancestors had left many millions of years earlier. The recognition of this early inland history aids in explaining the mystery of the late appearance and early rarity of vertebrates. In the older portion of the Paleozoic—Cambrian, Ordovician, and much of the Silurian—known surviving sediments are almost exclusively marine in origin. Only toward the end of the Silurian do we find any considerable amount of continental deposits. And it is only when such deposits appear that the vertebrates swim into the paleontological picture. Their earlier history may have been a long one, but one which may forever remain unknown because of lack of continental deposits in which the record could be preserved.

The interpretation of the fresh vs. salt water history of fishes has a bearing on various morphological, physiological, and biochemical problems. It must be pointed out, however, that most of the modern fresh-water fishes are not, in all probability, aboriginal denizens of that environment. Very probably the teleosts of our inland waters are re-immigrants, whose ancestors had migrated into the seas in early Mesozoic times and only later returned to fresh waters.

In studying the Silurian and early Devonian occurrences of vertebrates, an interesting ecological feature became apparent. In the fresh-water deposits containing vertebrates of those times, invertebrate fossils are for the most part rare. In almost every instance, however, there were abundant remains of one invertebrate group—the eurypterids. These were Paleozoic water-dwelling arachnids, related to the modern horseshoe crab and the scorpions. The late Dr. William Patten believed them related to the vertebrates. Modern work does not tend to confirm the idea of any genetic relationship, but the evidence suggests, on the other hand, a very different type of "relationship"—that of the eaters and the eaten (Romer, 1933a). The eurypterids were predaceous types, on the average considerably larger than the small contemporary vertebrates. It seems highly probable that the vertebrates were, in the beginning, the "under dogs" and formed the food supply for these invertebrates, for there is little else in the known fossil content of these beds which would have afforded them subsistence. As time went on, in the Devonian and later periods, vertebrates tended to become larger, speedier, and more formidable, and probably ceased to be "easy marks" for the eurypterids. And, concomitantly, we find the eurypterids much reduced in numbers. They are rare beyond the early Devonian; the last survivor is recorded in the Permian. The vertebrate "under dogs" had finally triumphed.

This picture of the early vertebrates, leading a precarious existence under the threat of the eurypterids, appears to correlate in great measure with the history of skeletal evolution. Although endoskeletal ossification is present to a degree in the ostracoderms, the greater emphasis is on the development of dermal armor. Armor development is reasonably associated with defensive needs, as is also the development of the electric organs which the cephalaspids appear to have possessed. Eurypterids were the only known enemies. Armor reduction in the Devonian and later periods parallels the apparent freeing of the vertebrates from the eurypterid "menace."

It has been argued that the presence of a bony skeleton in the early lower fishes is not related in any way to function, but is due to a simple "deposition" of the calcium salts absorbed by the organisms from the surrounding water; that the early vertebrates lacked control over such deposition, and tended to lose their bony structure when they achieved the power to regulate their calcium metabolism (Westoll, 1942). It seems, however, extremely difficult to believe that the

highly varied, elaborate and complexly built skeletal structures of ostracoderms and placoderms can be interpreted in such simple fashion. To look ahead to the placoderms next to be considered, one may be skeptical about the application of this thesis to the arthrodires (Fig. 15), in which regulation over the stern half of the fish was so complete that no trace of scales is present, and regulation was so completely lacking toward the bow that a massive armor with complicated articulations was present.

Homer Smith (1939) has suggested that the development of armor was associated with the attempt to maintain the proper internal concentration of salts by isolating the fish from the surrounding fresh waters, contact with which through a moist skin would lead to dilution of the blood plasma. But, as any section of the plates and scales of ostracoderms will show, the thick and relatively impervious part of the armor lay beneath a superficial porous region close to the surface in which there was a rich vascular supply—a type of construction which would destroy most of the value of the armor under such a theory.

Returning from excursions into theory to the more solid facts of fish history, we may ascend a rung on the evolutionary ladder. We have not yet emerged from the piscine "underworld" into the sphere of the typical jawed fishes of the shark or higher bony fish types; before we do, we must consider a series of varied and peculiar types, characteristic of the Devonian, some of which are illustrated in Figures 11 to 21. These include the "spiny sharks" or acanthodians; the arthrodires or "jointed-necked" armored fishes, some of giant proportions; the little antiarchs with arthropod-like bony flippers; and a variety of other oddities. These various forms were in earlier days assigned in a variety of ways: some upon occasion to the ostracoderms; some tentatively allied to the sharks, others to the lungfishes; many or all, in desperation, were simply considered as *incertae sedis* by various writers. Part, at least, however, were often considered as forming a group (albeit a group of mysterious affinities) termed the placoderms; and we shall here regard them as constituting a Class Placodermi, fishes which, despite their peculiar specializations, are to be placed in a position at the base of the jaw-bearing vertebrates, above the Agnatha but definitely below the sharks or higher bony fishes in their level of organization.

As an introduction to the placoderms, and as furnishing clues to their general nature, we shall first consider the spiny "sharks" of the Order Acanthodii (Figs. 11, 12). Spines which may pertain to them are present in Silurian deposits, but they are first definitely recognizable in the early Devonian, when they were one of the most conspicuous elements in the vertebrate fauna. Before the middle of that period, however, they had been supplanted in great measure by more advanced fish groups, and they were from then on relatively rare, although they persisted until the Permian. Some aberrant marine genera grew to considerable size, but the typical acanthodians were small fishes, only one or a few inches in length. They are usually found crushed, and although they have been known for a century, the small size and imperfect preservation of their remains rendered their interpretation difficult. Careful restudy of the material by Watson (1937) has, however, yielded a considerable amount of information regarding their structure and phylogenetic position.

The name of "spiny sharks" often given to these little fishes is due to the facts that the fins, both median and paired, are invariably strengthened by stout spines, and that the tail, as in sharks, was strongly tilted upward in heterocercal fashion. Apart from this tail type, however, there is nothing to connect them with the sharks. A most notable difference lies in the body covering. In sharks the skin bears only isolated placoid "scales," tooth-like in structure; in acanthodians, on the other hand, the body was completely covered by a series of small flat bony scales, quite unlike the shark dermal denticles. Such a complete armor covering, as we have seen, was present in ostracoderms lower down the scale, and also in higher bony fishes of advanced position—never in sharks. The histological structure of the acanthodian scales resembles that of the higher fishes—specificially that found in the primitive members of the ray-finned fish series often termed "ganoids." The ganoid scale is one built of concentric layers, the superficial parts of which consist of a shiny, enamel-like material known as ganoine. Exactly the same structure is found in the acanthodian scale.

In addition to median fins, the acanthodians possessed unquestioned paired fins corresponding to the pectoral and pelvic appendages of higher fishes and land vertebrates. They were, however,

built upon a peculiar pattern. Each bore at its anterior margin a stout spine. Behind the spine, in some cases, there are preserved traces of a web of skin forming a fin membrane; and in this region there are sometimes—but very exceptionally—paired fins are restricted to two pairs, pectoral and pelvic, corresponding to the four limbs of inland vertebrates. All acanthodians have these two pairs. But in many cases additional paired spines, interpreted as accessory pairs of append

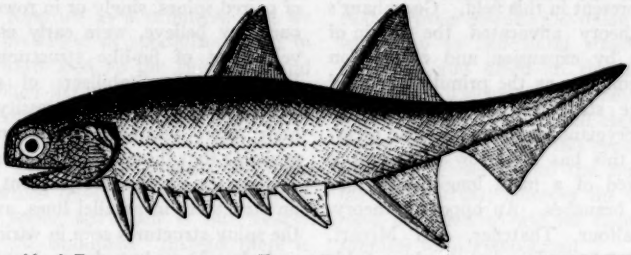

FIG. 11. A RESTORATION OF THE EARLY DEVONIAN ACANTHODIAN *CLIMATIUS*
(After Traquair; head modified after studies by Watson)

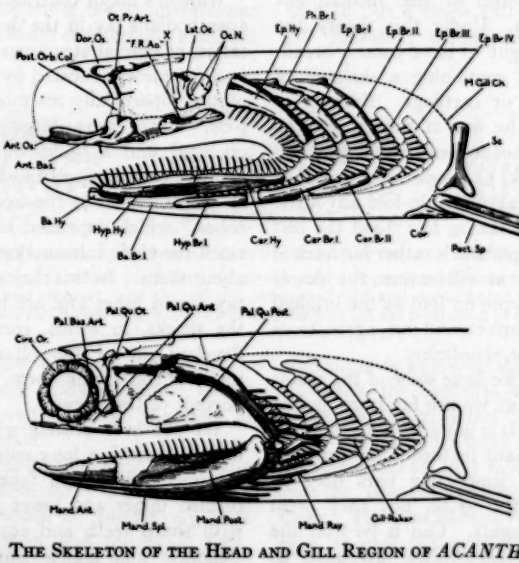

FIG. 12. THE SKELETON OF THE HEAD AND GILL REGION OF *ACANTHODES*

Above, gill skeleton preserved, but jaws not included. The hyomandibular (*Ep. Hy.*) is little enlarged or modified, and the gill rakers on this arch indicate the presence of a normal gill. Anteriorly, braincase ossifications are seen. *Below*, the endochondral jaw structures (in darker line) are added (as well as circumorbital plates). The upper jaw cartilage ossifies in three components, the lower jaw in two, to which a dermal element is added (*Mand. Spl.*) Mandibular rays presumably supported an opercular fold (more highly developed in Devonian genera). (From Watson).

found remains of parallel bars forming skeletal fin supports. The paired fins of higher fishes are movable to a greater or lesser degree. Here, however, the evidence is often clear enough to prove that the spine—and hence the fin—was immovably attached to the trunk. Still another peculiarity is present. In all higher vertebrates ages, are present between the pectoral and pelvic ones; in one genus as many as seven pairs were present. In the early days of "experimentation" in the development of limbs, it would seem that vertebrates had not, so to speak, made up their minds as to the number of limbs appropriate to them and that considerable variation may have

existed before they settled down to the orthodox number of two pairs.

Consideration of the paired fins as seen in acanthodians and other placoderms sheds new but somewhat confusing light on the old problem of the origin of paired fins. Two classic theories have long been present in this field. Gegenbaur's archipterygial theory advocated the origin of these structures by expansion and elaboration of gill flaps, producing, as the primitive type of fin, the leaf-like structure seen in lungfishes, certain crossopterygians, and the Paleozoic pleuracanth sharks; this has a narrow base and a skeleton composed of a main longitudinal axis with short side branches. An opposing theory, founded by Balfour, Thatcher, and Mivart, argued that paired fins originated simply as folds extending out laterally from the body much in the same way that dorsal or anal median fins appear to have arisen. Under this theory the primitive fin was thought to have been a broad-based lateral fin fold, containing a skeleton of parallel bars of bone or cartilage. Except for their narrower base, the fins of modern sharks and ray-finned bony fishes are built on this pattern, and the ancient shark *Cladoselache*, mentioned later, is close to the ideal of the fin-fold advocate. In general, the fin-fold theory has stood the test of time better than Gegenbaur's rather far-fetched ideas of fin origin. But as will be seen, the idea of a diagrammatically simple fin fold as the original fin type is probably incorrect, and due, again, to an unwarranted search for simplicity.

In the acanthodians we have some of the oldest of fin-bearing fishes; but we are far from finding this simple fold here. It is not a fold of skin but a spine that is the dominant feature of fin construction. A fin web and supporting bars may be present posterior to the spine, but they seem almost to be afterthoughts. Can it be that the paired fins of higher vertebrates originated as spiny structures; that later a fin membrane and its skeleton developed posterior to it, as seems to be occurring in the spiny "sharks"; and that, eventually, the spine tended to be lost in most cases, leaving a fin in which, with a narrowing of the base, motility was increased for more effective steering? As pointed out particularly by Westoll (1942), the original function of paired fins appears to have been that of stabilizing rudders that would have tended to prevent the rolling and pitching of a rather tadpole-like method of swimming, which alone was possible to a primitive fish lacking such structures. Much of the desired result would be obtained even if little or no fin motion were possible. We may note that fin spines persist in certain modern sharks and in a large array of their early fossil relatives. And we have seen in ostracoderms a high degree of development of paired spines, singly or in rows. These spines, one may believe, were early essays in the development of fin-like structures (Gregory and Raven, 1941). Stabilizers of some sort were desirable, and almost a necessity, as soon as the early fishes became active swimmers. It seems probable that there was a trend among the archaic vertebrates for the independent development of fin structures in parallel lines, and that not only the spiny structures seen in various ostracoderms and placoderms but also such things as the cephalaspid pectoral paddles were essays of this sort.

Watson's major contribution to the study of the acanthodians lay in the description and interpretation of cranial structures (Fig. 12). The head was completely covered by a series of small bony plates, superficially resembling those of the anaspids. There were large orbits (and a pineal opening) and a blunt snout, below the tip of which were the apertures for the paired nostrils. It is obvious that the acanthodians were "eye-fishes," which depended more on vision than on smell for their information concerning the world about them. In this they agreed with the modern ray-finned fishes and are in strong contrast with the sharks, in which, correlated with the great development of the olfactory organs and the rostrum containing them, smell is the most important of the senses.

We are here dealing with good jawed vertebrates; there is a long mouth slit, and in various specimens there are found well-developed and ossified upper and lower jaw bars, often armed with sharp teeth and equivalent to the palatoquadrate and mandibular cartilages of sharks. There is here no such fusion of visceral skeletal bars and braincase as was seen in the cephalaspids. Watson has found remains of a separate and typical braincase, ossified in great measure, with which the upper jaws articulate.

The mode of attachment of the upper jaws to the braincase is a feature of great theoretical interest in the study of the morphological evolution of vertebrates (Fig. 13). Until, in tetrapods, upper jaws are welded into a solid skull structure by means of closely associated dermal bones, it is necessary that the primary jaws (developed from

an anterior pair of gill bars) be braced in some fashion on the skull; they cannot float freely in the soft tissues of the head and be effective biting organs. In a few living fishes this support is autostylic; that is, the upper jaw connects directly with the braincase. But although this condition is theoretically regarded as a primitive one, we find it mainly preserved in specialized form in such eaters of hard food as the chimaeras and lungfishes in which actual fusion of upper jaw cartilage and braincase has occurred—presumably as a secondary condition.

The common type of jaw support in living fishes is that termed hyostylic. In this form of suspension the upper jaw itself is but loosely connected with the braincase. Instead there is brought into service the main upper element of the gill arch next behind the jaw. This is the hyoid arch, and its upper element is the hyomandibular cartilage or bone. Its lower end becomes attached by ligaments to the jaw-joint, its upper end is broadly based on the side of the braincase, and it thus becomes an efficient prop for the jaws in their masticatory function.

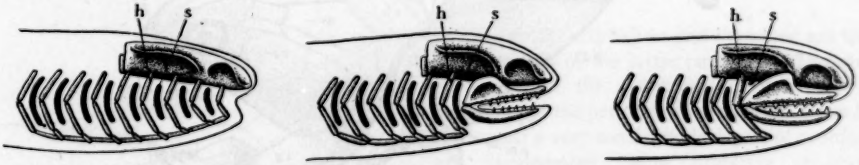

FIG. 13. A DIAGRAM TO SHOW THE EVOLUTION OF JAW SUPPORT AND THE SPIRACLE

Left, a primitive condition, in which jaws have not developed. *Center*, jaws developed, but the hyomandibular (*h*) is not concerned in their support, and the gill slit between hyoid and mandibular arches (*s*) is unspecialized. *Right*, the hyomandibular is developed as a jaw support and the first gill slit restricted to a spiracle.

Hand in hand with this development of hyostylic jaw support, there is necessarily a change in the nature of the gill slit which lay primitively back of the jaws, between them and the hyoid arch. Presumably this slit was originally a fully developed one, like its serial homologues back of it. But the union of the hyomandibular with the jaw joint would necessarily obstruct the slit, and reduce it to the condition seen in typical jawed fishes: a small round dorsal opening, the spiracle.

Morphology thus suggests that the primitive jawed vertebrate was a fish in which jaws had developed, but in which the hyoid was unspecialized, and the spiracular gill a fully developed slit. But this type of fish was a theoretical one only, until the appearance of Watson's paper in 1937. In this he demonstrated that the acanthodians were actually in this primitive evolutionary stage; the hyoid arch was unspecialized and, as proved by the presence there of a series of gill rakers, there was a fully developed hyoid gill slit just back of the jaw. Although the evidence is less clear, Watson points out that it is probable that the other peculiar Devonian fishes listed above were also in this basal stage of gnathostome evolution and allied to the acanthodians. He reasonably concluded that they may all be considered members of a basal class of jawed vertebrates. He coined for this group the term Aphetohyoidea (referring to the simple condition of the hyoid arch); however the writer and others have preferred to use for them the older (and simpler) term Placodermi.

In modern bony fishes the gills are protected by a flap of skin and bone, the operculum, so that there is but a single exit on either side from the gill chamber; among the sharklike fishes an operculum is found in the chimaeras; in the cyclostomes, the hagfishes, and among the ostracoderms, the Heterostraci likewise have gill coverings. On the other hand an operculum is lacking in sharks, skates and rays, and in the lampreys and the two ostracoderm orders affiliated with them. The placoderms—both acanthodians and most, at least, of the other members of that class—are to be ranged among the operculate fishes. In acanthodians, Watson describes a series of small plates which appear to have been embedded in an opercular flap over the gill region, and in other placoderms the gills are covered by solid plates of bone. He notes, however, one marked peculiarity of the placoderm operculum which suggests that it is not homologous with that of higher fishes. In those forms the opercular fold grows backward from the hyoid arch; the hyoid gill slit is not covered by the operculum and when preserved, as the spiracle, opens freely in front of that structure. In placoderms, in strong

contrast, the operculum grows back from the jaw arch, and covers the entire gill system.

Are the acanthodians, with their basic gnathostome structure, to be considered as ancestors of the higher fishes? The bony structure does not necessarily debar them, according to modern concepts, from being considered as ancestors to sharks or chimaeras as well as to the higher bony fishes; the spiny nature of the fins may well prove to be a primitive character. Watson, however, believes that the acanthodians are not ancestral to later types. To him the nature of the operculum is the main stumbling block. But the adequately known acanthodians are all from the Devonian or later periods when higher fish types were already in existence. Possibly the ancestral acanthodians of the Silurian, as yet almost unknown, may prove to be close to the common stem of all jawed vertebrates.

We may insert here a somewhat theological note. Analogous to Owen's position in England was Louis Agassiz's stand in this country, to the day of his death, against the acceptance of the doctrine of evolution. Although there appear to have been more religious factors concerned, his stated reasons (as given in a posthumous article in the "Atlantic" for January, 1874) are concerned mainly with fossil fishes, forms upon which much of his early scientific career had been spent.

> "If it be true that there has been a progressive transmutation of the whole type of Vertebrates, beginning with the lowest and culminating in the highest, the earlier should of course be structurally inferior to the later ones. . . . Let us look now at the earliest Vertebrates, as known and recorded in geological surveys. . . . They are Selachians and Ganoids, the highest of all living fishes, structurally speaking."

The older "ganoids" to which he refers are in great measure the ostracoderms and placoderms under discussion here; seemingly particularly prominent in his mind were the acanthodians, considered to be "selachian ganoids." According to the accepted tenets of his day, that a bony skeleton was a "high"—i.e., advanced—character, Agassiz was quite right in reaching the conclusion he did. Were he living today, his position, in the light of modern knowledge of skeletal evolution, might be a very different one.

The largest of all placoderm assemblages is that of the arthrodires, fishes with jointed necks, which were among the commonest of Devonian vertebrates, particularly in the seas of the late phases of that period. Best known members of the group are *Dinichthys* (Fig. 14) and other genera from the Cleveland shales of Ohio. Dean and Hussakof were earlier workers on the Cleveland shales arthrodires; Heintz (1932) has more recently described *Dinichthys*, and a monograph is to be published shortly by Dunkle, who has already published preliminary accounts of several members of this fauna (Dunkle and Bungart, 1945, and earlier papers).

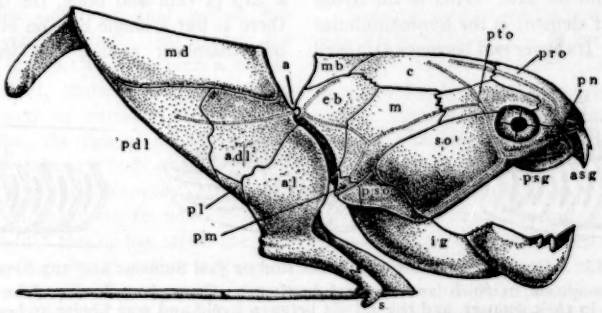

FIG. 14. SIDE VIEW OF THE ARMOR OF *DINICHTHYS*
Mainly after the large *D. terrelli*, in which the region shown is about 3 meters in length. (After Heintz, with additional data from Dunkle).

Dinichthys and its relatives were well armored bony fishes, but the posterior part of the body was in general naked and the armor confined to the head and "chest." The head and gill region were covered, top and sides, by a stout shield and there were jaw plates quite unlike the jaw structures of higher vertebrates. Internally nothing is known of head structures in *Dinichthys*, but in other genera there have been found ossified remains of the braincase and ossifications in the "primary" jaw structures; the braincase, with a small olfactory region, is rather like that of acanthodians.

The head skeleton, however, is only half the story. A second dermal bony structure was a belt of armor plate entirely surrounding the thoracic region. This segment of the armor articulated with the head shield by well-formed ball-and-socket joints; the head (as the name of the group implies) was freely movable up and down on the trunk, and some writers have fancied that mastication was performed by up-and-down movements of the head, the lower jaws (contrary to any orthodox procedure) remaining stationary during the process.

FIG. 15. SIDE VIEW OF THE SKELETON OF *COCCOSTEUS*, A SMALL RELATIVE OF *DINICHTHYS*
(From Heintz)

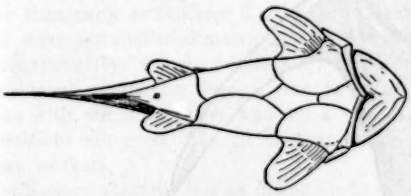

FIG. 16. VENTRAL VIEW OF *COCCOSTEUS*, WITH THE PAIRED FINS RESTORED
(From Heintz)

On the upper surface of the thorax, a carapace extended well down along the back, and ventrally a plastron-like structure covered the belly. Much of the flank was unprotected, but plates of bone lying behind the gill chamber on either side connected dorsal and ventral shields. This lateral armor belt is in the position of the dermal shoulder girdle, seen in bony fishes and their tetrapod descendants, and a similar dermal girdle was present in the acanthodians. At the lower lateral corner there may be present a small projecting spike of bone.

In *Dinichthys* little is preserved of the skeleton of the posterior part of the trunk and the tail. In a smaller relative, *Coccosteus* (Fig. 15), however, much of the internal structure is known (Heintz, 1931a; Watson, 1934). There appears to have been a heterocercal caudal fin, a dorsal fin, and (as suggested by a plate in appropriate position) an anal. Further forward on the ventral surface, a paired plow-shaped bone is in the position of a pelvic girdle. The question as to whether paired appendages were present was long disputed. It now appears, however, that they were present (Fig. 16), although seldom preserved in the specimens. A modest pair of pelvic fins sprang from the pelvic girdle; pectorals emerged from the slit behind the shoulder girdle. The pectoral fins, it will be noted, were bordered anteriorly by a spine projecting from the shoulder girdle, a feature, perhaps significant, which we have already seen in the acanthodians.

The typical arthrodires just described are those characteristic of the latter part of the Devonian. As we follow the arthrodires back toward the beginning of the period, we see that the group had undergone a very considerable degree of evolutionary development. Most primitive of known arthrodires are the forms which have been usually but (unfortunately) erroneously called acanthaspids, and for which Arctolepida is an appropriate term (Fig. 17). These forms alone represented the arthrodires in the earliest Devonian (Heintz, 1929; Bryant, 1932, 1933–34; Stensiö, 1942), and similar—perhaps even more primitive—types have been described very recently from fragmentary remains from the late Silurian (Stensiö, 1944); these last are the oldest morphologically identifiable remains of jawed vertebrates. In the arctolepids the posterior part of the body is unknown, but was presumably (as later) scaleless. The head and thorax are much flattened. The armor is relatively much thicker than in later arthrodires, and the trunk armor is more extensive in its development—particularly along the flanks. A most conspicuous feature is the development of the shoulder spines. Instead of the small vestiges seen in the later Devonian genera, there are here enormous hollow cones of bone extending stiffly far out and back from the body. Their function is difficult to determine. They may have been useful as stabilizers, and, with the animal at the bottom of the stream or lake, may have been effective anchors or hold-fasts in moving against a current.

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Above we have sketched high and low types on the "main line" of arthrodire evolution. There were, however, numerous other types of arthrodires. The literature on them is considerable; among major workers we may note Stensiö; (1934a, 1942 etc.), Heintz (1931b, 1938a, etc.), Watson (1934, 1937 in part, 1938) and Gross (1932, 1933a, 1933b). There were numerous side branches of the arthrodire stock, including for example, diverse flat-bodied forms such as *Homostius* and *Heterostius* (Heintz, 1934; Stensiö, 1938) and *Phyllolepis* and its relatives (Stensiö, 1934b, 1936, 1939b), the latter so depressed and degenerate that they were long thought to be ostracoderms. The ptyctodonts are small late Devonian fishes usually represented only by tooth-plates which armed their jaws.

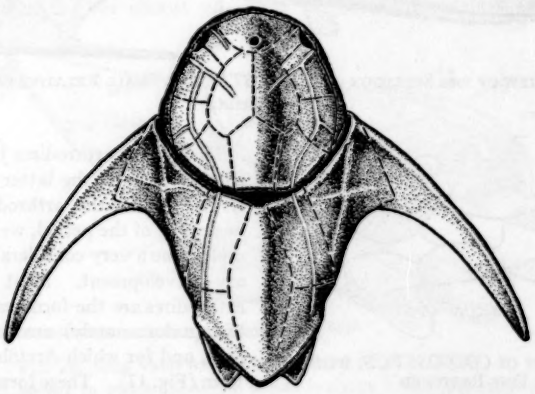

FIG. 17. A LOWER DEVONIAN ARTHRODIRE, *ARCTOLEPIS*, SEEN IN DORSAL VIEW

The pectoral spines, rudimentary in *Dinichthys* (*s*, Fig. 14) are here enormously developed. (Redrawn from Heintz's figures.)

Dollo had in 1907 maintained that they were arthrodires, and the recent discovery of ptyctodont skeletons has confirmed his belief (Watson, 1934, 1938). The ptyctodonts, incidentally, not only bear stout pectoral spines but an enormous dorsal spine as well.

The taxonomic and evolutionary position of the arthrodires was hotly debated for decades. By some they were thought to be allied to the lungfish. Others denied that they were gnathostomes at all, maintained that the seeming jaw structures were not really such, and assigned them to the ostracoderms. Stensiö has advocated relationship to the sharks. Currently, the evidence leads to the conclusion that they are essentially in a position intermediate between these various extremes, and that they are properly assignable as primitive jawed vertebrates to the Placodermi. Although they differ from the acanthodians in many notable features, it is not unreasonable to assume a common ancestry in some as yet unknown Silurian type of spiny-finned primitive-jawed bony fish. The gill skeleton is unknown in arthrodires; but the absence of a spiracular opening and the presence of a bony gill covering extending back from the jaw region suggests a structure basically similar to that of acanthodians.

Still other grotesque types are to be found among the placoderms. *Macropetalichthys*, for example, is a fish from mid-Devonian rocks which has been known for a century. For most of this time, however, all that was known of it was a dermal skull roof (Fig. 18), of a pattern not at all comparable to that of any other fish. Progress in knowledge was made through the discovery by Stensiö (1925b) that beneath this roof there was a well ossified braincase, of rather arthrodire-like pattern and containing a brain and other structures which that author believed were rather selachian in nature (this conclusion is not, however, supported by more recent work; cf. Moy-Thomas, 1939b, pp. 37, 46). In the last few years the place of *Macropetalichthys* was finally established through the discovery of remains of a related genus, *Lunaspis* (Fig. 19) (Broili, 1930a; Heintz, 1937; Gross, 1937a), in which the greater part of the body was preserved. There was present a thoracic belt of armor, with enormous lateral spines, comparable to that of primitive arthrodires; and a feature in which these fishes were even more primi-

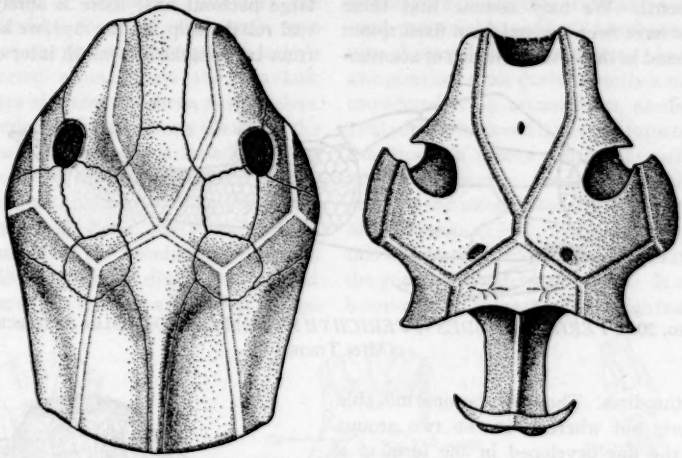

FIG. 18. *MACROPETALICHTHYS*, A MIDDLE DEVONIAN PLACODERM
Left, dorsal view of elongate cranial shield; *right*, the underlying endocranium. (Redrawn from Stensiö.)

tive than early arthrodires is that the trunk and tail were not naked-skinned but scale-covered. *Macropetalichthys* and its relatives are thus to be considered as another branch from a common stem with the arthrodires, and by a stretch of definitions are even included in that group by some workers.

Still more aberrant but as definitely to be associated with the arthrodires in the placoderm assemblage are the Antiarchi (Gross, 1931, 1937a; Stensiö, 1931, 1945). These were small fishes, very abundant at certain localities in the Upper Devonian (at Scaumenac Bay in eastern Canada, for example). In basic features (Fig. 20) they resembled the arthrodires. As in that group, there was a subdivision of armor into cephalic and thoracic segments, the two movably articulated; the bony pattern of the thoracic armor is almost identical with that of arthrodires; the tail may be either scaled (as it was in *Lunaspis*), or naked as in typical arthrodires. But in other regards these little fishes are quite distinctive. The head shield is short and small, the eyes and nostrils pinched close together above; the jaws were but a feeble nibbling apparatus. The presence of pelvic fins is doubtful. As to the pectorals, we find a peculiar pair of lobster-like appendages which resemble those of no other animal whatever. These are jointed, and freely movable, bone-covered but hollow (except at the base where endochondral

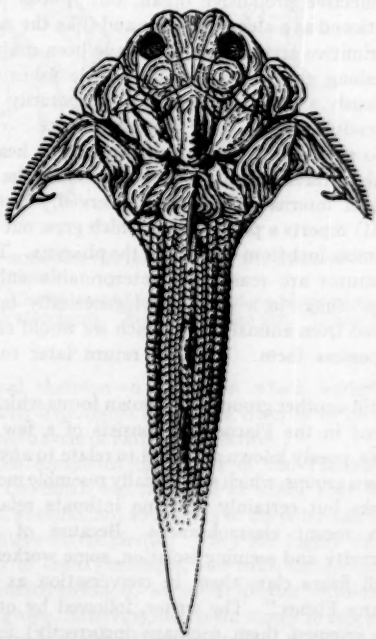

FIG. 19. *LUNASPIS*, A FORM RELATED TO *MACROPETALICHTHYS*, IN WHICH MUCH OF THE BODY IS PRESERVED
The large pectoral spines are comparable to those of *Arctolepis*. (After Broili, with data added from Gross and Heintz.)

bone is present). We may assume that these motile organs have been derived from fixed spines such as are found in the shoulder region of acanthodians and arthrodires. They have become movable fins of a sort; but whereas, in the two groups mentioned, the fins developed in the form of a membrane posterior to the spine, here the spine itself has become the fin structure. The shape of this "flipper" indicates that it could not have been an effective propulsive organ, but it may have functioned as a steering device and (like the spines of primitive arthrodires) may have been useful in life along the bottom. These little fishes were obviously a very aberrant (but temporarily very successful) branch of the placoderm stock.

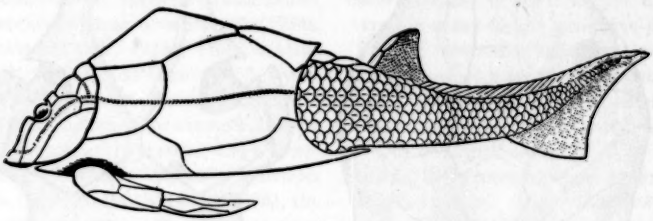

FIG. 20. *PTERICHTHYODES* (*PTERICHTHYS*), A MIDDLE DEVONIAN ANTIARCH
(After Traquair)

No endoskeletal bone is present in the head or trunk of these animals, but in some cases the outlines of internal organs are preserved. Denison (1941) reports a pair of sacks which grew out by a common duct from the floor of the pharynx. These structures are reasonably interpretable only as lungs—lungs in a group phylogenetically far removed from animal types which we would expect to possess them. We shall return later to this topic.

Still another group of Devonian forms which are placed in the Placodermi consists of a few rare types, poorly known and hard to relate to any well known groups, which superficially resemble modern sharks but certainly have no intimate relations with recent elasmobranchs. Because of their obscurity and seeming isolation, some workers on fossil fishes class them in conversation as "the Funny Fishes." The writer, followed by others, has grouped them (perhaps incorrectly) in the Order Stegoselachii (Broili, 1930b, 1933a, 1933b; Gross, 1937a). One of the best known of these odd creatures is *Gemuendina* (Fig. 21), from the Lower Devonian of the Rhineland. Its superficial appearance is that of a modern ray, because of the large pectoral fins; there is surely, however, no real relationship, for the rays, we know, developed from true sharks at a much later date; and forms related to *Gemuendina* had much smaller pectorals. The dermal covering of the body is partly in the form of scale-like structures, partly isolated tubercles resembling shark placoid "scales."

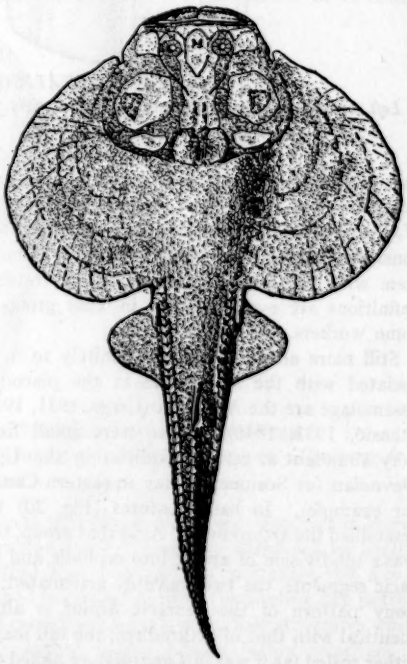

FIG. 21. *GEMUENDINA*, A LOWER DEVONIAN STEGOSELACHIAN

Although there are "remains" of a cephalic shield in the form of isolated plates, and a pectoral armor (not clearly distinguished in the figure), there is no pectoral spine and the pectoral fins are expanded in the fashion of a skate. (From Broili.)

The mouth was a terminal structure; the nostrils (rather like those of antiarchs) were close together on the snout. *Gemuendina* lacks a solidly constructed aromor, and the fins lack spines; but traces of armor are there, nevertheless. There are a number of isolated bony plates on the roof of the head; and there is a broad pectoral girdle, reminiscent of the thoracic armor of the acanthodians and arthrodires. *Gemuendina* gives one the impression that it is a placoderm which is osteologically in a state of "dissolution," with the head armor well along toward disappearance, and with a reduction of the thoracic armor that has, so

structures beneath this braincase; a well preserved (and presumably ossified) backbone; little in the way of possible limb structures. As to its systematic position, some (until recently a majority) have considered it an ostracoderm, as did Bulman in 1931; others believed it a larval form of some higher fish group (a theory which the ossification of its vertebral column renders unlikely). At the moment the most reasonable assumption is that of Moy-Thomas (1940), the most recent student of this worrisome fishlet, who believes it to belong in the general placoderm category. It will be noted, however, that there is not the slightest trace of any

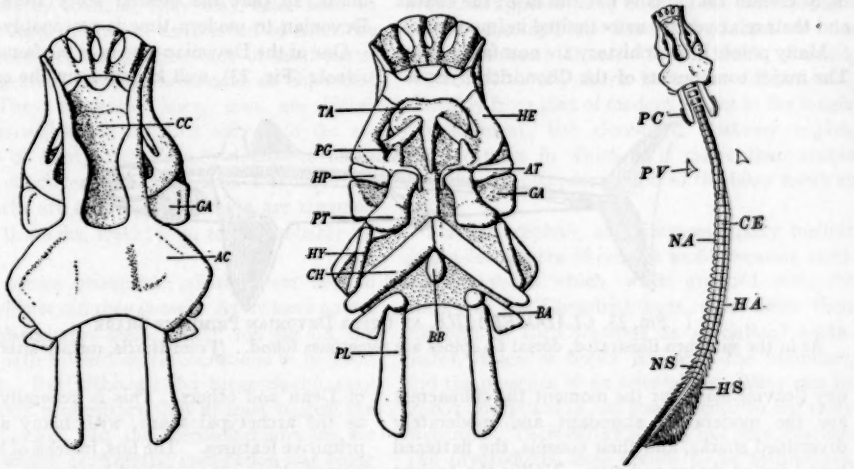

FIG. 22. *PALAEOSPONDYLUS*, A SMALL FISH OF UNCERTAIN AFFINITIES FROM THE MIDDLE DEVONIAN OF SCOTLAND

Left, dorsal view of the braincase and associated structures. *Center*, ventral view of the same, showing various bars, etc., which may belong to a modified series of visceral arch structures. *Right*, the entire fish. (From Moy-Thomas.)

to speak, allowed the pectoral fins to flow outward in a vast expansion. In some of *Gemuendina's* relatives—such as *Pseudopetalichthys* (Moy-Thomas, 1939b, p. 54; Broili, 1933a)—the head armor is still a compact set of arthrodire-like plates. *Gemuendina* and the other "funny fishes" are like nothing else under the sun; but perhaps they may best be described as structurally half way between arthrodire and shark.

A perennial problem (perennial, that is, since its discovery half a century ago) is the position to be assigned to *Palaeospondylus* (Fig. 22). This is a tiny little fish, an inch or two in length, almost all remains of which come from a single quarry in the mid-Devonian of northern Scotland. It exhibits a braincase; a number of peculiar bars and other dermal skeleton—a condition which under the modern hypothesis supported here, is to be considered as one of extreme reduction.

This completes the roster of the Placodermi. The Devonian was the time at which they flourished, as dominant successors to the older and more primitive ostracoderms. They are highly varied, many of them grotesque, and none known can be considered as exactly ancestral to later vertebrates. As a group, however, they seem surely to represent the base of the gnathostome stock. Having added jaws of a simple sort and essays in the development of paired limbs to the ostracoderm inheritance of a bony skeleton, they appear to have, presumably toward the end of the Silurian, engaged in the exploration of various possibilities in structural

patterns and modes of life. The results of this radiation of experimental types of jawed vertebrates are seen in the Devonian placoderms. Of the well known groups, almost all became extinct before the end of the Devonian. It is reasonable to assume that the higher fish classes which, as we shall see, came into existence in the Devonian were derived from other segments, as yet unknown or poorly known, of a Silurian placoderm radiation.

Under the ideas of fish evolution once prevalent, the Chondrichthyes—the cartilaginous fishes of which the sharks are typical—were thought to be the primitive jawed vertebrates. It is now seemingly certain that this is not the case; the sharks and their relatives are more limited in importance.

Many points in their history are now fairly clear. The major components of the Chondrichthyes today (leaving aside for the moment the chimaeras) are the moderately abundant and moderately diversified sharks, and their cousins, the flattened broad-finned skates and rays. Unlike the ancient forms considered above, there is not a bone in their bodies; the internal skeleton is purely cartilaginous (although sometimes the cartilage is calcified); there are no dermal bones and, apart from fin spines present in a few forms, the surface of the body has for hard parts only isolated "placoid scales" or dermal denticles. Modern cartilaginous fishes (including the chimaeras as well) frequently enclose their fertilized eggs in hard capsules, and the males have the pelvic fins produced into claspers which aid in the necessary internal fertilization.

Following back along the history of the group, sharks and rays of modern type can be traced downward to the Jurassic. In the lower strata of that period, however, neither modern sharks nor rays are found, and the only sharks which can be traced on down through the Triassic and into the Paleozoic are *Hybodus* and its relatives (Brough, 1935). These are relatively primitive forms. Stout spines are present on the dorsal fins; more significant is the fact that although the hyomandibular aids in jaw support, there is also the more primitive direct connection of braincase and upper jaw (amphistylic suspension).

In the Carboniferous and the later part of the Devonian, remains of early sharks are moderately abundant (Moy-Thomas, 1935c, 1936b, 1939a). There are numerous spines, and teeth generally called *Cladodus*. In the late Devonian two very primitive shark types are known which bore such teeth, and in the Carboniferous there are genera apparently transitional from them to the hybodonts, so that the general story from the late Devonian to modern time is reasonably clear.

One of the Devonian genera is the famous *Cladoselache* (Fig. 23), well known from the early work of Dean and others. This is generally regarded as the archetypal shark, with many apparently primitive features. The fins, instead of having the narrow base seen in modern forms, are broad-based folds, the skeleton formed by parallel bars of cartilage. The specialized pelvic claspers of the modern catilaginous fishes are absent. A second genus, *Ctenacanthus*, is less well known but has as good or better claims to primitivity. It appears to have resembled *Cladoselache* in many regards, but bore (as in the later hybodonts) long spines as cutwaters on both the dorsal fins. *Cladoselache* is usually restored as spineless, but in some instances at least (Harris, 1938), dorsal fin spines are present. The primitive presence of spines is suggestive of conditions in still lower vertebrate groups.

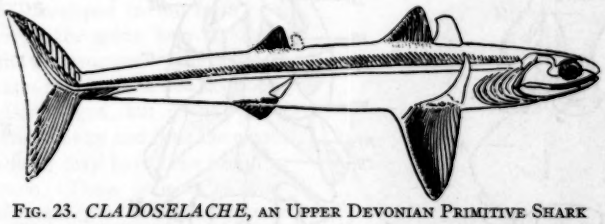

FIG. 23. *CLADOSELACHE*, AN UPPER DEVONIAN PRIMITIVE SHARK
As in the specimen illustrated, dorsal fin spines are sometimes found. (From Harris, mainly after Dean.)

From modern times down to and through the later Devonian there are, at almost every horizon, abundant remains of sharks, although these remains are usually incomplete in nature and mainly consist of teeth and spines. Back of the latter half of the Devonian, however, the record stops completely. There are no remains of the Chondrich-

thyes in older strata; the shark-like fishes are the last evolved of fish types, for members of the higher fish groups had appeared before this.

What is the earlier pedigree of the sharks? According to our older ideas, as we have said, these cartilaginous forms were supposed to be the basal stock of the gnathostomes. But our knowledge of lower types of fishes, reviewed above, casts grave doubts upon this theory, once generally accepted, and the relatively late appearance of the group makes their primitive nature still more dubious. It has been argued hopefully that since they are cartilaginous fishes, and cartilage does not ordinarily fossilize, they may have been in existence long before but have failed to enter the fossil record because of their lack of hard parts. This suggestion, however, overlooks an important point. They possessed jaws; jaws are biting structures which can function only with the association of hard parts—usually teeth—to make the bite effective. From the later Devonian on, once sharks are known, shark teeth are common fossils. If sharks, teeth; if no teeth, probably no sharks.

If, as seems reasonable, sharks were late to evolve, whence did they come? As we have noted, known placoderms seem mostly too far off the possible path toward shark conditions to be good ancestors. But although the Stegoselachii may not be shark progenitors, they at least suggest the mode of origin. In the stegoselachians we see forms in which, apparently, ossification was being reduced; dermal bones were in process of "solution," scales were giving place to denticle-like structures, fin spines were being reduced, and broad-based paired fins of more "normal" appearance were evolving. There is as yet no positive proof of such an evolutionary development, but the most reasonable hypothesis of the origin of sharks is that they have evolved from primitive placoderm gnathostomes by skeletal degeneration.

We have noted that the early fish habitat was presumably fresh waters. However, the placoderms appear to have trended strongly toward a marine existence, and the main line of shark evolution has been one taking place in salt waters since the first appearance of the group in the late Devonian. The fossil record indicates that the sharks have taken up marine life independently of the higher bony fishes, and this conclusion has been independently arrived at from the study of kidney structure and function (Homer Smith, 1936).

One exception to this rule of a typically marine existence for sharks is found in a group known as the Pleuracanthodii. These were shark-like fishes abundant in the Carboniferous and Permian, which differed from typical early sharks in numerous features of teeth, fins, etc., and also differed in being characteristic of fresh water environments. I hope on some future occasion to describe, from abundant material, the braincase and jaw structures of *Pleuracanthus*, of which so far I have published merely preliminary illustrations (Romer, 1933b, 1945). Except for a point of attachment for a specialized cephalic spine, the pleuracanth braincase appears to be built on the same pattern as the incompletely known braincase of the cladoselachians (Gross, 1937b, 1938b; Stensiö, 1937a). The old shark braincase differed considerably from that of modern sharks in the longer otic segment, less developed olfactory region, etc.—features in which it is closer than recent types to the placoderms and to the bony fishes as well.

The Holocephali, or chimaeras, today include only a few genera of oceanic mollusc-eating cartilaginous fishes which, while grouped with the sharks in the Chondrichthyes, differ from their relatives in such features as specialized toothplates, fusion of upper jaw with the braincase, and the presence of an operculum. They can be traced downward in the fossil record to the early Mesozoic. Their earlier history has been obscure. The ptyctodonts, now known to be arthrodires, were once considered chimaera ancestors, but this idea is now generally discredited (although there are tantalizing suggestions of similarity).

We have long known from the later Paleozoic—terminal Devonian, Carboniferous, and Permian—numerous remains (mainly the dentition and spines) of fishes known as "pavement-toothed sharks" because of their dental apparatus of plate-like structures apparently adapted to the trituration of molluscs or other hard invertebrates. Smith Woodward (1921) united them in an Order Bradyodonti, the name referring to the fact that, unlike the sharks, the tooth succession (if any) was a slow process. Moy-Thomas (1935a, 1936a, 1939a; De Beer and Moy-Thomas, 1935) has been the major student of these forms. One bradyodont family—that of *Cochliodus* and its allies—seems rather surely to have given rise to the later chimaeras. The nature of the other bradyodonts is, however, more problematical, and it is possible that the order may prove to be an artificial one—

merely a convenient dumping-ground for a variety of early feeders on the molluscs which appear to have abounded in the Carboniferous seas. There is no definite evidence as to the origin of the group, but the presence of claspers suggests a close relationship to the early sharks, from which they may have evolved in late Devonian times.

The final major group of primitive water-dwellers is that of the Osteichthyes, the higher bony fishes. The name is not, of course, a distinctive one, for, as we have seen, bone is by no means confined to this fish group and the evidence suggests that their ancestors had possessed this skeletal tissue since the earliest days. Nevertheless, the Osteichthyes have tended to cling rather tenaciously to bone, in contrast to their cousins, the shark-like fishes. In both groups we have an advance over the placoderms in the development of hyostylic jaw suspension and the specialization of the spiracle; but the sharks, it would appear, have undergone skeletal degeneration, and the Osteichthyes, on the whole, have not.

In the older classification the bony fishes were arrayed in two groups—lungfishes and teleostomes. In our modern concepts of their phylogeny a twofold classification is also customary; but the dichotomy is a different one. It now appears that the lungfish are not as distinct as was once thought (nor are they primitive), but are an offshoot of the crossopterygians. These two groups may be combined as a subclass Choanichthyes (Romer, 1937; Herpetichthyes Huxley, Smith Woodward 1931; Amphibioidei Hubbs, 1919). The second subclass is that of the ray-finned fishes, the Actinopterygii, of which the familiar teleosts are the modern representatives.

The ray-finned types are in strong contrast with the Choanichthyes in numerous regards. They differ markedly, even in their earliest representatives, in many basic features of the skeleton, and the living forms show equally strong contrasts in their soft anatomy. Even in readily-determined superficial features the two are readily distinguished. The early actinopterygians, for example, had but a single dorsal fin, the choanate fishes two. Both types had, to begin with, a markedly heterocercal shark-like tail, but the ray-finned fishes generally lacked a dorsal (epichordal) lobe, so that later evolution of this structure differed in the two groups—ray-fins tended toward the homocercal tail of the modern teleost type, Choanichthyes, with development of the epichordal lobe, to a diphycercal structure. Seldom in actinopterygians is there a developed lobe in the paired fins; as the name implies, these structures are mainly a ray-stiffened skin web, with the skeleton of parallel bars confined to the base of the fin. In the choanate fishes, on the other hand, there is a well developed fleshy and scale-covered fin lobe, containing a skeleton of archipterygial type. In early members of both groups the scales are thick structures with a shiny surface, and the term "ganoid" is often applied indiscriminately to members of both groups. Actually, however, the ganoid scale is found only in actinopterygians; the crossopterygians and lungfishes have, to begin with, a very different scale—the cosmoid type. In the Choanichthyes—as the name implies—internal nostrils were generally present; they are not found in actinopterygians.

Jarvik (1944b) denies that the internal nostril of the lungfish is a true choana, and claims that it is actually a modified external nose opening. His thesis, however, does not appear to me to be sufficiently established; it neglects the marked reduction which we find in the jaw margins of modern Dipnoi.

It is thus obvious that there are profound differences between the two major groups into which modern practice sharply divides the higher bony fishes, and the differences were as marked when we first find their early representatives as fossils as they are today. Since the presence of bone is, as we have seen, not in itself a distinctive character, a definition of the Class Osteichthyes is difficult if not impossible. We can do little more than say that they are jawed fishes which have attained a hyostylic type of jaw suspension like their shark cousins but have, in contrast to these forms, retained an ossified skeleton. Such a negative definition is unsatisfactory. It is possible that the class is not a natural unit, and that the two subgroups have evolved separately from the placoderm level. For the present, however, this is an unproved assumption.

The earliest Actinopterygii appear in the Middle Devonian—in advance, it will be noted, of the earliest sharks (the crossopterygians were still earlier). These forms, ancestral to the modern teleosts, are known as palaeoniscids (Fig. 24); they were relatively rare until late in the Devonian, but were the dominant fresh-water fishes from the Carboniferous through the early Triassic, and survived in limited numbers until the early Cretaceous before succumbing to their more advanced ray-finned descendants. At one time all were in-

cluded in a single family, many in the single genus *Palaeoniscus*. The past two decades, however, have shown that there was a vast amount of variation within the palaeoniscid group; and scores of genera are known (Aldinger, 1937; Brough, 1931, 1939; Moy-Thomas, 1934, 1937b; Moy-Thomas and Dyne, 1938; Nielsen, 1936, 1942; Piveteau, 1935; Stensiö, 1925a, 1932a; Watson, 1925, 1928; Westoll, 1937a, 1944; White, 1927, 1939).

We need not enter into the bewildering details of the palaeoniscoid radiation, which may have rivaled that of the modern teleosts, but will simply note such characters as the customary presence of thick and shiny scales of the true ganoid type (preserved in the modern gar pike), and of a shark-like heterocercal tail.

It has long been recognized that two types of living ray-finned fishes are primitive in nature and hence to be regarded as living relatives of the palaeoniscids. These are the sturgeons (*Acipenser*, etc.) and the paddle-fishes (*Polyodon* of the Mississippi, and a relative from Chinese rivers). In them we see the typical heterocercal tail. But the ganoid scales are lacking—the paddle-fish is nearly destitute of scales, and the sturgeon has rows of simple bony plates. Further, while endochondral ossification was well developed in the palaeoniscids (the braincase was more stoutly ossified than in any modern teleost), the sturgeons and paddle-fishes are almost entirely cartilaginous—there is hardly a bone in the body. This last feature was once thought to be a primitive one. But older sturgeons were better ossified (Watson, 1928), and we have here a process of bone degeneration quite comparable to that which we have witnessed in lower vertebrate groups.

Parenthetically, we can draw a close parallel between these living primitive ray-finned fishes—usually termed the Chondrostei—and the sharks. It would have taken but a little further loss of bone to reduce them to a completely cartilaginous condition. Had this been accomplished, and were we ignorant of their fossil history, we would have—under classic theories—believed firmly that they were primitive cartilaginous fishes, just as the sharks were thought to be. In the case of the Chondrostei, however, we know that this belief is false. The shark situation is as yet unproved by fossil evidence, but the situation is reasonably to be regarded as parallel.

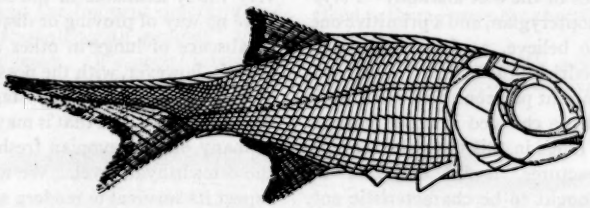

FIG. 24. A CARBONIFEROUS PALAEONISCID, *CANOBIUS*
(From Moy-Thomas and Dyne)

FIG. 25. *POLYPTERUS*, A LUNG-BEARING LIVING SURVIVOR OF THE PALAEONISCIDS, ONCE THOUGHT TO BE A CROSSOPTERYGIAN
(From Goodrich, after Agassiz)

We appear to have in *Polypterus* (Fig. 25) and a less well known relative, *Calamoichthys*, from central Africa, quite another type of fish which is a living representative of the palaeoniscids. *Polypterus* is specialized in its median fins (as the name implies) and, unlike most actinopterygians, has a fleshy pectoral fin; further, in contrast to proper ray-finned fishes, *Polypterus* has in its thorax not the usual single dorsal air-bladder of more advanced members of this group, but paired ventral lungs, simple in structure but similar in build and function to those of lungfishes and land vertebrates. Because of these last two features, *Polypterus* was classed by Huxley among the Crossop-

terygii, the major group of the Choanichthyes. The weight of Huxley's opinions is a heavy one, and even today many a text continues to cite *Polypterus* as a crossopterygian and it is so described in many a classroom, although students of fish evolution have realized the falsity of this position for many years. Actually, it has no affinity with crossopterygians. The lobate fin is unusual, it is true, in actinopterygians, but a fleshy lobe was developed in some palaeoniscids; and the skeleton contained in this lobe is not at all like the archipterygium of crossopterygians. In every other respect—the presence of good ganoid scales, the absence of choanae, the pattern of the skull, many features of the soft anatomy—*Polypterus* is a good actinopterygian, and a primitive one. It is reasonable to believe, as first conclusively pointed out by Goodrich (1928) that *Polypterus* is a survivor of the ancient palaeoniscids, modified in fin structure, but little changed in other features.

The presence of lungs in this fish calls for comment. These structures, useful only for air breathing, were thought to be characteristic only of the close relatives of the ancestral tetrapods. It is often taught that the air bladder of typical ray-finned fishes—a single dorsal sac—is a more primitive piscine structure and that the tetrapod lung may have been derived from it in some fashion. It now appears that the reverse is probably the case. The lungfish evidence (Goodrich, 1909, 1930) indicates that migration from a ventral to a dorsal position is more probable (and structurally more advantageous) than the opposite movement. The presence of a lung in the most primitive known ray-finned fish, when all more advanced types have the air bladder, fairly clinches the argument. It is at present reasonable to assume that the primitive bony fishes were in possession of typical lungs.

The functional reason for the existence of these structures in the early bony fishes is apparent if we consider the ecological factors. The lung-bearing modern fishes live in regions where there are marked seasonal droughts; lungs (and the external gills found likewise in these forms) are useful aids in gaining extra oxygen beyond the meager supply that the gills can extract from restricted and stagnant waters. Barrell (1915) and others called attention to geological data indicating that the Devonian period was a time when seasonal droughts were prevalent; lungs would have been very advantageous to fishes living under such conditions. Beyond the Devonian, such droughts became relatively rare phenomena; most lung-bearing fishes either died out in competition with fishes with adaptations more advantageous for the times, or else, perhaps, modified the lung into a hydrostatic organ useful for other purposes.

It has been generally assumed that even though the lung was probably a common feature in all types of early Osteichthyes, it was "invented" by that group, and was not present in lower fish classes (sharks, for example, show no evidence of such a structure). We mentioned above, however, the recent discovery of a lung-like structure in the antiarchs—specialized placoderms which are surely far off the line of ancestry of the bony fishes. Traces of such features of the soft anatomy are very rarely available in the fossil record, and we have no way of proving or disproving the presence or absence of lungs in other archaic fishes. We are left, however, with the possibility that the lung was developed at an early stage in the history of the vertebrates, and that it may have been common in many other Devonian fresh-water forms below the osteichthyan level. We would not, of course, expect its survival in modern sharks, even if it had been present in their ancestors, since lungs would be not only useless but (as raising the center of gravity) a handicap to a marine fish.

The Crossopterygii are the major members of the Subclass Choanichthyes. The group has been a firmly established one since Huxleyan days. The first crossopterygians appear in the early Devonian —before the ray-finned fishes, long before the sharks, and at a time when placoderms and even ostracoderms still abounded. They are thus an early fish type, and we have as yet no proper antecedent forms to connect them (nor their ray-finned cousins) with more primitive bony fishes on the placoderm level from which we may now reasonably assume them to have arisen. Their origin must have occurred at least as early as the late Silurian, but no recognized ancestors are found in the fresh-water beds of Europe or eastern North America, from which our only known Silurian fossil fishes have been obtained. They may have originated in some other continental area, or in inland waters from which no sediments have survived (for it is, of course, a sad fact that cycles of geological uplift and erosion so operate that the chances of survival of upland sediments formed in early periods are very slight indeed).

During the middle and late Devonian the typical crossopterygians, of which *Osteolepis* (Fig. 26) *Eusthenopteron*, and *Holoptychius* are representative, were among the commonest of fresh-water

fishes. By the beginning of the Carboniferous, however, the actinopterygians far outnumbered them (climatic changes may have been a factor here), and the last survivor of the typical crossopterygians—the Rhipidistia of usual terminology—is an early Permian form.

We have noted above some of the major features in which the Choanichthyes, as best exemplified by the crossopterygians, differ from their ray-finned osteichthyan cousins. We have every reason to believe that lungs were present in the rhipidistians, and the internal nostrils were of course useful accessories in the utilization of these air-breathing organs. We have mentioned the presence here of cosmoid scales rather than the ganoid structure, and the frequent description of these fishes as "crossopterygian ganoids" is, of course, a gross misnomer. Of especial interest is the paired fin structure. All crossopterygians showed distinctive suggestions of tetrapod conditions in vena cava, brain, etc.

The answer, we now see, is simple. *Polypterus*, as noted above, is not a crossopterygian, but an actinopterygian, and hence can tell us nothing about crossopterygian anatomy and embryology. The lungfishes, on the other hand, are a specialized offshoot of the crossopterygian stock, and we may confidently assume that many of the features of their soft anatomy and developmental history are retentions of the characters possessed by their crossopterygian ancestors. Keeping in mind the cranial and dental specializations of the Dipnoi, we are definitely led to the firm conclusion that the crossopterygians—or at least forms very closely allied to them—were the ancestors of the tetrapods.

Säve-Söderbergh (1934) advocated a diphyletic origin for the tetrapods, arguing, on slight grounds,

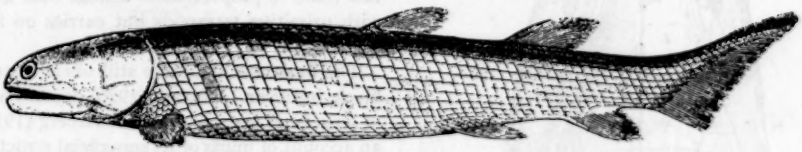

FIG. 26. *OSTEOLEPIS*, A MIDDLE DEVONIAN RHIPIDISTIAN CROSSOPTERYGIAN

have developed a scale-covered finlobe, presumably containing stout muscles, and having in its center a well developed fin skeleton. In some forms the fin was a typical leaf-shaped archipterygium, as in the related lungfishes; in most, however, it is an abbreviated archipterygium, with a much shortened axis.

It was long ago suggested that the crossopterygians might be considered for the honorable post of ancestors of the tetrapods, but on the whole the dipnoans were the more favored. The tendency to advocate consideration of the dipnoans was due in great measure to the fact that *Polypterus* was then considered to be a crossopterygian, although obviously not a typical one. The rhipidistians, however, are defunct, and *Polypterus* furnished the only available evidence regarding the soft anatomy and embryology of the Crossopterygii—so it was thought. In these respects it proved most disappointing. Its mode of development was essentially that of the ray-finned fishes; the embryology of the lungfish is, on the contrary, highly comparable to that of amphibians. The soft anatomy of *Polypterus* showed little to suggest the tetrapods; the dipnoans, despite obvious specializations, that while most land forms were of crossopterygian descent, the urodeles had come from dipnoan-like ancestors. Jarvik (1944b) also claims a similar dichotomy, but a simpler one, from two different crossopterygian types.

In the earlier years of the century Gregory and Goodrich were proponents of the theory of crossopterygian ancestry of the tetrapods. The data then available, however, was none too satisfactory, and was confined mainly to superficial features. A considerable number of recent workers have added greatly to our knowledge of crossopterygian anatomy (Bryant, 1919, Jarvik, 1937, 1942, 1944a, 1944b; Romer, 1937, 1941; Säve-Söderbergh, 1933; Watson, 1926; Westoll, 1936, 1937b).

As a result of this work satisfactory comparisons between these fishes and the primitive tetrapods have been established; the evidence is summarized by Westoll (1943; cf. Watson, 1926). The fin structure of many crossopterygians has long been known to be of a type from which, by distal modification and considerable expansion, the tetrapod limb may have arisen (Gregory and Raven, 1941). Little data is as yet available as to vertebral evolution (Gregory, Rockwell and Evans, 1939;

Westoll, 1943), but it is probable that evolutionary developments in this respect will eventually be correlated.

The pattern of dermal bones in the skull and jaws of crossopterygians and labyrinthodonts were readily comparable in many respects. A major problem, however, appeared to resist solution (Fig. 27). In land animals, the pineal eye opening is situated between the pair of parietal bones of the skull roof. In crossopterygians, on the other hand, the opening appears between a pair of bones which at one time all agreed were homologous with the frontals of tetrapods. The position of the

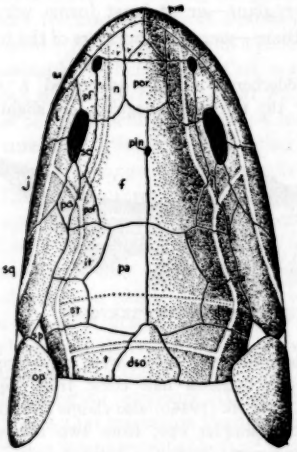

FIG. 27. DORSAL VIEW OF THE SKULL ROOF OF *EUSTHENOPTERON*, SHOWING THE FORMER INTERPRETATION OF THE BONY ELEMENTS

The pineal opening is between the bones identified as the frontals, whereas in tetrapods they lie between the parietals (Fig. 28 *D*).

opening is very stable, and the apparent contradiction was a puzzling one. Säve-Söderbergh (1933) attempted a solution on the assumption that both frontals and parietals were, despite their usual seeming simplicity, compound elements, and their components might be, so to speak, cut apart with shears and pasted together in various combinations so that the pineal might seem to shift its position without actually doing so. This, however, satisfied no one. The writer, without realizing it, found part of the solution when he pointed out (1936a) that the bones at the back of the skull which were usually homologized with the postparietals (dermal supraoccipitals) and tabulars were not properly skull elements but enlarged scales. It remained, however, for Westoll (1936, 1938) to point out the correct solution—simple, once you see it. Actually, there has been no shift in the position of the pineal, and there is no need to call upon unproved complexities in the structure of the bones concerned. The bones between which the opening lies in the crossopterygians, and which are in the position of the tetrapod frontals, are actually the parietals; the large elements behind them, once thought to be parietals, are actually greatly expanded postparietals. In the change from fish to tetrapods, there has been a major change in skull proportions and relative reduction in the posterior part of the skull roof. Westoll was fortunate enough to find, in the Upper Devonian of Scaumenac Bay, a skull roof (advanced crossopterygian or very primitive tetrapod?) which nicely splits the difference; and the writer (Romer, 1941; Fig. 28 of this paper) has pointed out that this trend in proportionate change does not cease with primitive tetrapods but carries on into the reptiles.

The braincase structure still offers a stumbling block, however. Watson (1926) pointed out some of its general features; Säve-Söderberg (1936) gave an account of much of its superficial structure; the writer (1937; Fig. 29 of this paper) was able, from serial sections, to give a fairly complete account; Jarvik (1937, 1942) has described the nasal region in great detail. Most of the braincase structures can be readily compared with those of labyrinthodont amphibians.

There is, however, one major point of difference. The crossopterygian braincase is formed in two segments, the one movable on the other, and with a large canal in the posterior structure through which the notochord runs forward to abut against the anterior one just behind the pituitary region. Nothing of this sort is seen in any land animal. This situation has led many to assume that the situation in known crossopterygians is a specialization, and that the tetrapod ancestor must be sought in some more generalized, but as yet unknown, crossopterygian type. It is, however, possible that there was a welding of the two units into one in the evolution of the tetrapod. Some suggestion of this is seen in the fact that two segments are present in the early embryology of the braincase in many tetrapods, and that there is a distinct gap in internal ossification between the two halves in the adult of various Paleozoic amphibians.

The last typical crossopterygians became extinct in the Permian. A specialized offshoot, however,

survived—the coelacanths (Fig. 30) (Aldinger, 1930; Jarvik, 1942; Moy-Thomas, 1935b, 1937a, Moy-Thomas and Westoll, 1935; Schaeffer, 1941; Stensiö, 1921, 1932a, 1937b; Watson, 1921; Westoll, 1939). These aberrant forms became marine types, apparently in the Triassic, and marine fossil coelacanths are known from Jurassic and Cretaceous deposits. None is found in later sediments, and (with the exclusion of *Polypterus* from the group) it was customary to state emphatically that the Crossopterygii were entirely extinct and had been extinct since Cretaceous days. This statement is a prime example of the uncertainties of conclusions reached from negative evidence. One day in 1938, a South African fisherman seined up, from 40 fathoms, an unusual fish which he brought ashore and presented to the local museum at East London. When brought to the attention of a scientist (Smith, J. L. B., 1939), it proved to be a living coelacanth, which he named *Latimeria*. The reason for the absence of a post-Cretaceous fossil record is undoubtedly the fact that the coelacanths had become denizens of the high seas, from the deep sediments of which geologic strata are seldom formed. The fish, sad to say, was eviscerated and stuffed before its scientific importance was realized, so that little anatomical data is available. It is to be hoped that the recurrence of peace may see a search made for further specimens. It is, however, probable that the anatomy of *Latimeria* will be of relatively little use in attempting to determine the structure of the early crossopterygians, for the major change of environment which the coelacanths have undergone has undoubtedly been accompanied by major structural changes.

From what has been said above, it can be seen that the Dipnoi are currently of relatively little

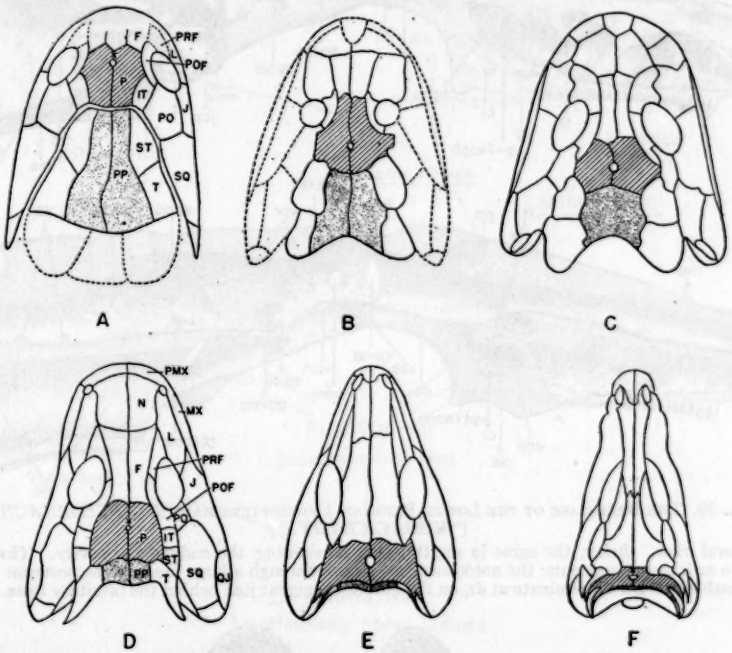

FIG. 28. A SERIES OF SKULLS IN DORSAL VIEW, SHOWING CHANGES OF PROPORTIONS FROM CROSSOPTERYGIANS TO PERMIAN REPTILES

The posterior elements steadily undergo relative reduction. Throughout, the parietals are hatched, the postparietals stippled. *A*, the crossopterygian *Osteolepis; B, Elpistostege* of the early Upper Devonian (advanced crossopterygian or primitive amphibian?); *C, Ichthyostega*, a primitive amphibian of the late Devonian or early Mississippian; *D, Palaeogyrinus*, a Carboniferous labyrinthodont; *E, Romeria*, a cotylosaurian reptile; *F, Dimetrodon*, an early Permian pelycosaurian reptile. (*B* after Westoll, *C* after Säve-Söderbergh, *D* after Watson, *E* after Price.)

importance in the broader evolutionary picture. They are, however, an interesting group in their own rights, and we have added considerably to our knowledge of them (Forster-Cooper, 1937; Goodrich, 1925; Hills, 1933; Romer, 1936a; Watson and Gill, 1923; Weitzel, 1926). Dollo in 1896 showed that most of the known lungfishes formed a gradually changing series leading from the oldest type, *Dipterus* of the Middle Devonian, through later Paleozoic genera and *Ceratodus* of the Triassic to

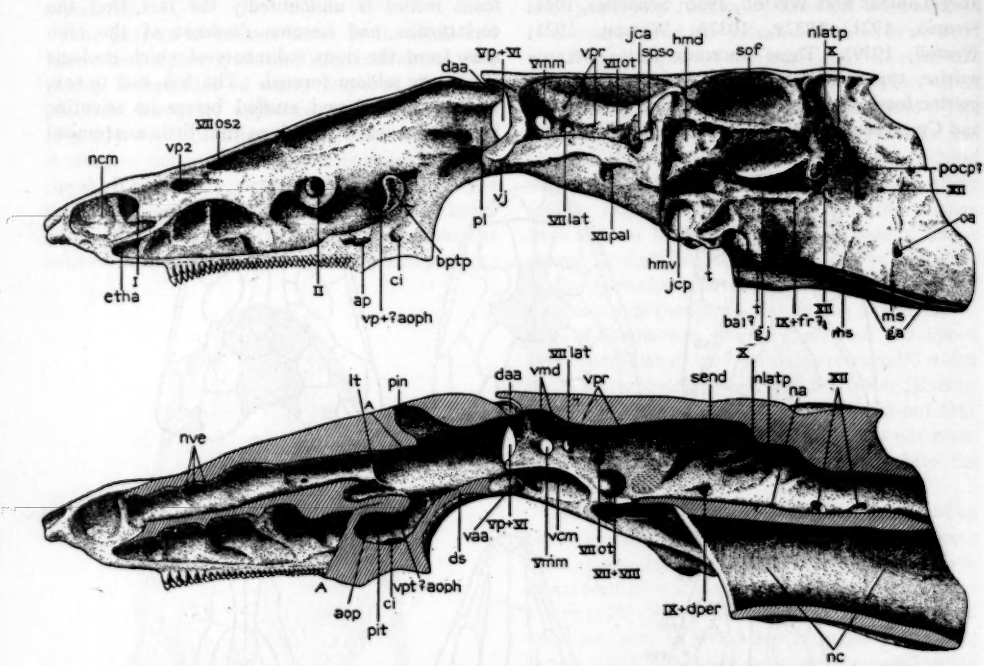

FIG. 29. THE BRAINCASE OF THE LOWER PERMIAN CROSSOPTERYGIAN *ECTOSTEORHACHIS* ("*MEGALICHTHYS*")

Above, lateral view. *Below*, the same in sagittal section, showing the endocranial cavity. The braincase is formed in two articulated segments; the notochord (*nc*) passed through a large canal in the posterior segment and forward beneath the brain to terminate at *ds*, on the anterior segment just behind the pituitary fossa.

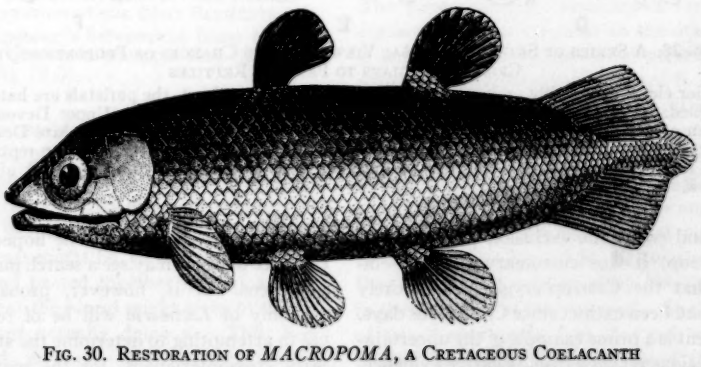

FIG. 30. RESTORATION OF *MACROPOMA*, A CRETACEOUS COELACANTH

The recently discovered *Latimeria* is similar in appearance. (From Smith Woodward.)

the living *Epiceratodus* of Australia (*Protopterus* of Africa and *Lepidosiren* of South America are more specialized). We now see that as this series is traced back it converges into that of the Crossopterygii, of which the Dipnoi are a specialized offshoot (some writers, indeed, would include them in the crossopterygians in a broad sense). Some side branches are known, including long-snouted late Devonian genera (Säve-Söderbergh, fibrous structures; most of the dermal bones of the head have been done away with; the internal skeleton has become almost entirely cartilaginous. We see here a final example among fishes of the story of skeletal degeneration which was noted repeatedly in our account of other groups. Were we to continue into a discussion of land types, we would find a further repetition of the same process in the history of the amphibians.

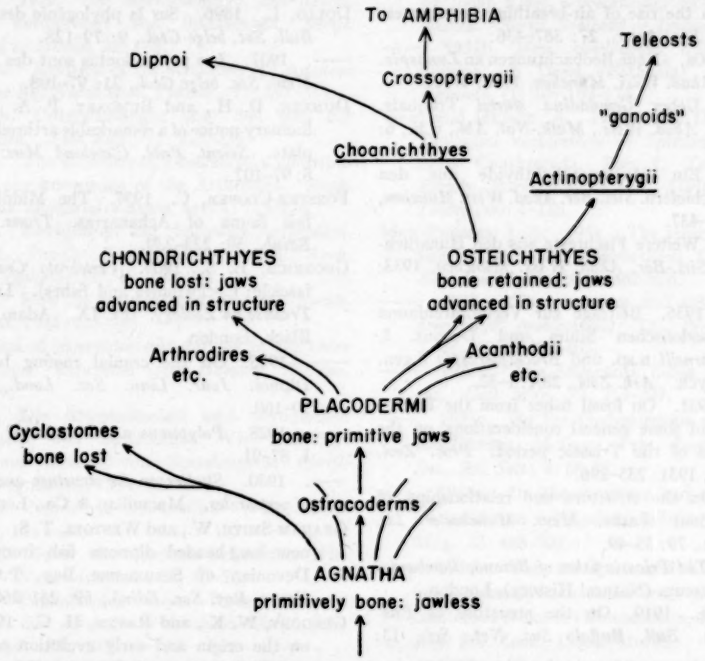

FIG. 31. A DIAGRAM OF THE PHYLOGENY OF THE FISHES ACCORDING TO CONCEPTS DEVELOPED IN RECENT YEARS

1937; Graham-Smith and Westoll, 1937); but on the whole, once the dipnoans acquired their peculiar specializations including the unique tooth-plates and the functionally associated fusion of upper jaws with braincase, they strayed little from the main phyletic line.

During the evolution of the Dipnoi, the nature of the skeleton has been much modified. The very oldest lungfishes had stout cosmoid scales, a highly developed cranial armor, and a considerable degree of internal ossification. During the course of geological time, much of the hard skeleton has been lost. The scales have been reduced to

In Figure 31 is given, in contrast with our first figure, an outline of the probable phylogeny of fishes as it stands today as a result of the work of the past two decades. As has been seen, this phylogeny is in many ways markedly different from that in which we believed in the earlier part of the century; and in many other regards, as well, our views have been vastly changed by recent work. Our present concepts are not, of course, to be considered as in any way definitive. They are merely, we hope, a closer approximation to the truth, and a basis from which will stem the work in the new era of paleoichthyology now beginning.

LIST OF LITERATURE

AGASSIZ, L. 1874. Evolution and permanence of type. *Atlantic Monthly*, 1874: 1–12.

ALDINGER, H. 1930. Ueber das Kopfskelett von *Undina acutidens* Reis und den kinetischen Schädel der Coelacanthiden. *Cbl. Min. Geol. Paläont.*, Abt. B, 1930: 22–48.

——. 1937. Permische Ganoidfische aus Ostgrönland. *Medd. om Grønland*, 102: 1–392.

BARRELL, J. 1915. Influence of Silurian-Devonian climates on the rise of air-breathing vertebrates. *Bull. Geol. Soc. Amer.*, 27: 387–436.

BROILI, F. 1930a. Neue Beobachtungen an *Lunaspis*. *Sitz.-Ber. Akad. Wiss. München*, 1930: 47–57.

——. 1930b. Ueber *Gemündina stürtzi* Traquair. *Abh. bayer. Akad. Wiss., Math.-Nat. Abt.*, n.F., 6: 1–24.

——. 1933a. Ein Macropetalichthyide aus den Hunsrückschiefern. *Sitz.-Ber. Akad. Wiss. München*, 1933: 417–437.

——. 1933b. Weitere Fischreste aus den Hunsrückschiefern. *Sitz.-Ber. Akad. Wiss. München*, 1933: 269–313.

BROTZEN, F. 1936. Beiträge zur Vertebratenfauna des westpodolischen Silurs und Devons. I. *Protaspis arnelli* n.sp. und *Brachipteraspis* n.gen. *latissima* Zych. *Ark. Zool.*, 28A: 1–52.

BROUGH, J. 1931. On fossil fishes from the Karroo System, and some general considerations on the bony fishes of the Triassic period. *Proc. Zool. Soc. Lond.*, 1931: 235–296.

——. 1935 On the structure and relationships of the hybodont sharks. *Mem. Manchester Lit. Philos. Soc.*, 79: 35–49.

——. 1939. *The Triassic fishes of Besano, Lombardy*. British Museum (Natural History), London.

BRYANT, W. L. 1919. On the structure of *Eusthenopteron*. *Bull. Buffalo Soc. Nat. Sci.*, 13: 1–23.

——. 1926 On the structure of *Palaeaspis* and on the occurrence in the United States of fossil fishes belonging to the family Pteraspidae. *Proc. Amer. Philos. Soc.*, 65: 256–271.

——. 1932. Lower Devonian fishes of Bear Tooth Butte, Wyoming. *Proc. Amer. Philos. Soc.*, 71: 225–254.

——. 1933–34. The fish fauna of Beartooth Butte, Wyoming. *Proc. Amer. Philos. Soc.*, 72: 285–314; 73: 127–162.

——. 1935. *Cryptaspis* and other Lower Devonian fossil fishes from Beartooth Butte, Wyoming. *Proc. Amer. Philos. Soc.*, 75: 111–141.

——. 1936. A study of the oldest known vertebrates, *Astraspis* and *Eriptychius*. *Proc. Amer. Philos. Soc.*, 76: 409–427.

BULMAN, O. M. B. 1930. The general morphology of the anaspid *Lasanius*, Traquair. *Ann. Mag. Nat. Hist.*, (10) 6: 354–362.

——. 1931. Note on *Palaeospondylus gunni*, Traquair. *Ann. Mag. Nat. Hist.*, (10) 8: 179–190.

CHAMBERLIN, T. C. 1900. On the habitat of the early vertebrates. *Jour. Geol.*, 8: 400–412.

DE BEER, G. R., and MOY-THOMAS, J. A. 1935. On the skull of Holocephali. *Philos. Trans. Roy. Soc. Lond.*, B, 224: 287–312.

DENISON, R. H. 1941. The soft anatomy of *Bothriolepis*. *J. Paleont.*, 15: 553–561.

DOLLO, L. 1896. Sur la phylogénie des *Dipneustes*. *Bull. Soc. belge Géol.*, 9: 79–128.

——. 1907. Les ptyctodontes sont des arthrodères. *Mém. Soc. belge Géol.*, 21: 97–108.

DUNKLE, D. H., and BUNGART, P. A. 1945. Preliminary notice of a remarkable arthrodiran gnathal plate. *Scient. Publ. Cleveland Mus. Nat. Hist.*, 8: 97–102.

FORSTER-COOPER, C. 1937. The Middle Devonian fish fauna of Achanarras. *Trans. Roy. Soc. Edinb.*, 59: 223–239.

GOODRICH, E. S. 1909. *Vertebrata Craniata* (First fascicle: Cyclostomes and fishes). Lankester's *A Treatise on Zoology*. Pt. IX. Adam and Charles Black, London.

——. 1925. On the cranial roofing bones in the Dipnoi. *Jour. Linn. Soc. Lond., Zool.*, 36: 79–160.

——. 1928. *Polypterus* a palaeoniscid? *Palaeobiol.*, I, 87–91.

——. 1930. *Studies on the structure and development of vertebrates*. Macmillan & Co., London.

GRAHAM-SMITH, W., and WESTOLL, T. S. 1937. On a new long-headed dipnoan fish from the Upper Devonian of Scaumenac Bay, P.Q., Canada. *Trans. Roy. Soc. Edinb.*, 59: 241–266.

GREGORY, W. K., and RAVEN, H. C. 1941. Studies on the origin and early evolution of paired fins and limbs. *Ann. N. Y. Acad. Sci.*, 42: 273–360.

——, ROCKWELL, H., and EVANS, F. G. 1939. Structure of the vertebral column in *Eusthenopteron foordi* Whiteaves. *J. Paleont.*, 13: 126–129.

GROSS, W. 1930. Die Fische des Mitteleren Old Red Süd-Livlands. *Geol. Pal. Abh.*, n.F., 18: 121–156.

——. 1931. *Asterolepis ornata* Eichw. und das Antiarchi-Problem. *Palaeontogr.*, 75: 1–62.

——. 1932. Die Arthrodira Wildungens. *Geol. Pal. Abh.*, n.F., 19: 5–61.

——. 1933a. Die Wirbeltiere des rheinischen Devons. *Abh. Preuss. Geol. Landesanst.*, n.F., 154: 1–83.

——. 1933b. Die Fische des baltischen Devons. *Palaeontogr.*, 79, Abt. A: 1–74.

——. 1937a. Die Wirbeltiere des rheinischen Devons. Teil II. *Abh. Preuss. Geol. Landesanst.*, n.F., 176: 1–83.

——. 1937b. Das Kopfskelett von *Cladodus wildungensis* Jaekel. I. Teil: Endocranium und Palatoquadratum. *Senckenbergiana*, 19: 80–107.

——. 1938a. Der histologische Aufbau der Anaspiden-Schuppen. *Norsk. Geol. Tidsskr.*, 17: 191–195.

——. 1938b. Das Kopfskelett von *Cladodus wildungensis* Jaekel. II. Teil: Der Kieferbogen. *Senckenbergiana*, 20: 123–145.

HARRIS, J. E. 1938. The dorsal spine of *Cladoselache*. *Scient. Pub. Cleveland Mus. Nat. Hist.*, 8: 1–6.

HEINTZ, A. 1929. Die downtonischen und devonischen Vertebraten von Spitzbergen. *Skrift. Svalbard og Ishavet*, 22: 1–81.

——. 1931a. Revision of the structure of *Coccosteus decipiens* Ag. *Norsk Geol. Tidsskr.*, 12: 291–313.

——. 1931b. Untersuchungen über den Bau der Arthrodira. *Acta Zool.*, 12: 225–239.

——. 1932. The structure of *Dinichthys*, a contribution to our knowledge of the Arthrodira. *Bashford Dean Memorial Volume*, art. 4: 115–224.

——. 1934. Revision of the Estonian Arthrodira. Part I. Family Homostiidae Jaekel. *Arch. Naturk. Estlands*, (1), 10: 180–290.

——. 1935. How the fishes learned to swim. *Smithson. Rept.* 1934: 223–245.

—Discussion of locomotor adaptations in the older fish groups. Reprinted from *Naturen*, 58, nos. 7, 8, 1934.

——. 1937. Die downtonischen und devonischen Vertebraten von Spitzbergen. VI. *Lunaspis*-Arten aus dem devon Spitzbergens. *Skrift. Svalbard og Ishavet*, 72: 1–23.

——. 1938a. Notes on Arthrodira. *Norsk Geol. Tidsskr.*, 18: 1–27.

——. 1938b. Ueber die ältesten bekannten Wirbeltiere. *Naturwissensch.*, 26: 49–58.

——. 1939. Cephalaspida from Downtonian of Norway. *Skr. Norske Videnskaps-Akad. Oslo, Mat.-Naturv. Kl.*, 1939: 1–119.

HILLS, E. S. 1933. On a primitive dipnoan from the Middle Devonian rocks of New South Wales. *Ann. Mag. Nat. Hist.*, (10) 11: 634–643.

HUBBS, C. L. 1919. The Amphibioidei, a group of fishes proposed to include the Crossopterygii and the Dipneusti. *Science* (n.s.), 49: 569–570.

JAEKEL, O. 1902. Ueber verschiedene Wege phylogenetischer Entwickelung. *Verh. internat. Zool. Kongr. Berlin*, 1901: 1058–1117.

JARVIK, E. 1937. On the species of *Eusthenopteron* found in Russia and the Baltic states. *Bull. Geol. Inst. Univ. Upsala*, 27: 63–127.

——. 1942. On the structure of the snout of crossopterygians and lower gnathostomes in general. *Zool. Bidr. Uppsala*, 21: 237–675.

——. 1944a. On the exoskeletal shoulder-girdle of teleostomian fishes, with special reference to *Eusthenopteron foordi* Whiteaves. *K. Svenska Vetenskapsakad. Handl.*, (3) 21: 1–32.

——. 1944b. On the dermal bones, sensory canals and pit-lines of the skull in *Eusthenopteron foordi* Whiteaves, with some remarks on *E. säve-söderberghi* Jarvik. *K. Svenska Vetenskapsakad. Handl.* (3) 21: 1–48.

KIAER, J. 1924. The Downtonian fauna of Norway. I. Anaspida. With a geological introduction. *Skr. Vid. Selsk. Kristiania*, I, (6): 1–139.

——. 1932a. The Downtonian and Devonian vertebrates of Spitzbergen. IV. Suborder Cyathaspida, by Johan Kiaer, a preliminary report edited by A. Heintz. *Skrift. Svalbard og Ishavet*, 52: 1–26.

——. 1932b. New coelolepids from the Upper Silurian on Oesel (Esthonia). *Arch. Naturk. Estlands*, (1) 10: 169–174.

——, and HEINTZ, A. 1935. The Downtonian and Devonian vertebrates of Spitsbergen. V. Suborder Cyathaspida. Part I. Tribe Poraspidei. Family Poraspidae Kiaer. *Skrift. Svalbard og Ishavet*, 40: 1–138.

MOY-THOMAS, J. A. 1934. The structure and affinities of *Tarrasius problematicus* Traquair. *Proc. Zool. Soc. Lond.*, 1934: 367–376.

——. 1935a. The structure and affinities of *Chondrenchelys problematica* Tr. *Proc. Zool. Soc. Lond.*, 1935: 391–403.

——. 1935b. The coelacanth fishes from Madagascar. *Geol. Mag.*, 72: 213–227.

——. 1935c. On the Carboniferous shark, *Petrodus patelliformis*, McCoy. *Proc. Leeds Philos. Lit. Soc., Sci. Sect.*, 3: 68–72.

——. 1936a. On the structure and affinities of the Carboniferous cochliodont *Helodus simplex*. *Geol. Mag.*, 73: 488–503.

——. 1936b. The structure and affinities of the fossil elasmobranch fishes from the Lower Carboniferous rocks of Glencartholm, Eskdale. *Proc. Zool. Soc. Lond.*, 1936: 761–788.

——. 1937a. The Carboniferous coelacanth fishes of Great Britain and Ireland. *Proc. Zool. Soc. Lond.*, B, 107: 383–415.

——. 1937b. The palaeoniscids from the cement stones of Tarras Waterfoot, Eskdale, Dumfriesshire. *Ann. Mag. Nat. Hist.*, (10) 20: 345–356.

——. 1939a. The early evolution and relationships of the elasmobranchs. *Biol. Rev.*, 14: 1–25.

——. 1939b. *Palaeozoic fishes*. Methuen & Co., London. (An excellent systematic account of the older fish groups.)

——. 1940. The Devonian fish *Palaeospondylus gunni* Traquair. *Philos. Trans. Roy. Soc. Lond.*, 230B: 391–413.

——, and DYNE, M. B. 1938. The actinopterygian fishes from the Lower Carboniferous of Glencartholm, Eskdale, Dumfriesshire. *Trans. Roy. Soc. Edinb.*, 59: 437–480.

MOY-THOMAS, J. A., and WESTOLL, T. S. 1935. On the Permian coelacanth, *Coelacanthus granulatus* Ag. *Geol. Mag.*, 72: 446–457.

NIELSEN, E. 1936. Some few preliminary remarks on Triassic fishes from East Greenland. *Medd. om Grønland*, 112: 1–55.

——. 1942. Studies on Triassic fishes from East Greenland. I. *Glaucolepis* and *Boreosomus*. *Palaeozool. Groenlandica*, 1: 1–403.

OBRUCHEV, D. 1943a. An attempted restoration of *Psammolepis paradoxa*. *C.R. (Doklady) Acad. Sci. URSS*, 42: 143–145.

——. 1943b. A new restoration of *Drepanaspis*. *C.R. (Doklady) Acad. Sci. URSS*, 41: 268–271.

PATTEN, W. 1912. *The evolution of the vertebrates and their kin*. Blakiston, Philadelphia.

PIVETEAU, J. 1935. Paléontologie de Madagascar. XXI. Les poissons du Trias inférieur. Contribution à l'étude des Actinoptérygiens. *Ann. Pal.*, 23: 81–180.

ROBERTSON, G. M. 1935a. *Oeselaspis*, a new genus of Ostracoderm. *Amer. Jour. Sci.*, (5) 29: 453–461.

——. 1935b. The ostracoderm genus *Dartmuthia* Patten. *Amer. Jour. Sci.*, (5) 29: 323–335.

——. 1938. The Trematapsidae. Part I. *Amer. Jour. Sci.*, (5) 35: 172–206.

ROMER, A. S. 1933a. Eurypterid influence on vertebrate history. *Science*, 78: 114–117.

——. 1933b. *Vertebrate Paleontology*. Univ. Chicago Press, Chicago.

——. 1936a. The dipnoan cranial roof. *Amer. Jour. Sci.*, (5) 32: 241–256.

——. 1936b. Studies on American Permo-Carboniferous tetrapods. *Problems of Paleontology*, 1: 25–93.

——. 1937. The braincase of the Carboniferous crossopterygian *Megalichthys nitidus*. *Bull. Mus. Comp. Zool.*, 82: 1–73.

——. 1941. Notes on the crossopterygian hyomandibular and braincase. *J. Morph.*, 69: 141–160.

——. 1942. Cartilage an embryonic adaptation. *Amer. Nat.*, 76: 394–404.

——. 1945. *Vertebrate Paleontology*. Second edition. Univ. Chicago Press, Chicago.

——, and GROVE, B. H. 1935. Environment of the early vertebrates. *Amer. Mid. Nat.*, 16: 805–856.

SÄVE-SÖDERBERGH, G. 1933. The dermal bones of the head and the lateral line system in *Osteolepis macrolepidotus* Ag. with remarks on the terminology of the lateral line system and the dermal bones of certain other crossopterygians. *Nova Acta Reg. Soc. Sci. Upsala*, (4) 9: 1–129.

——. 1934. Some points of view concerning the evolution of the vertebrates and the classification of this group. *Ark. Zool.*, 26A: 1–20.

——. 1936. On the morphology of Triassic stegocephalians from Spitsbergen, and the interpretation of the endocranium in the Labyrinthodontia. *K. Svenska. Vetenskapsakad. Handl.*, (3) 16: 1–181.

——. 1937. On *Rhynchodipterus elginensis* n.g., n.sp., representing a new group of dipnoan-like Choanata from the Upper Devonian of East Greenland and Scotland. *Ark. Zool.*, 29B: 1–8.

SCHAEFFER, B. 1941. A revision of *Coelacanthus newarki* and notes on the evolution of the girdles and basal plates of the median fins in the Coelacanthini. *Amer. Mus. Novit.*, 1110: 1–17.

SMITH, H. W. 1932. Water regulation and its evolution in the fishes. *Quart. Rev. Biol.*, 7: 1–26.

——. 1936. The retention and physiological role of urea in the elasmobranchs. *Biol. Rev.*, 11: 49–52.

——. 1939. Studies in the physiology of the kidney. *Univ. Kansas, Porter Lecture Series*, IX: 1–106.

SMITH, J. L. B. 1939. A living coelacanthid fish from South Africa. *Trans. Roy. Soc. S. Africa*, 28: 1–106.

SOLLAS, W. J. 1903. A method for the investigation of fossils by serial sections. *Philos. Trans. Roy. Soc. Lond.*, B, 196: 259–263.

STENSIÖ, E. A. 1921. *Triassic fishes from Spitzbergen*. Part I. Holzhausen, Vienna.

——. 1925a. Triassic fishes from Spitzbergen. Part II. *K. Svenska Vetenskapsakad. Handl.*, (3) 2: 1–261.

——. 1925b. On the head of the macropetalichthyids. *Field Mus. Nat. Hist. Geol.*, 4: 89–198.

——. 1927. The Downtonian and Devonian vertebrates of Spitzbergen. Part I. Family Cephalaspidae. *Skrift. Svalbard og Nordishavet*, 12: 1–391.

——. 1931. Upper Devonian vertebrates from East Greenland, collected by the Danish Greenland expedition in 1929 and 1930. *Medd. om Grønland*, 86: 1–212.

——. 1932a. Triassic fishes from East Greenland, collected by the Danish expeditions in 1929–1931. *Medd. om Grønland*, 83: 1–305.

——. 1932b. *The cephalaspids of Great Britain*. British Museum (Natural History), London.

——. 1934a. On the heads of certain arthrodires. I. *Pholidosteus*, *Leiosteus* and acanthaspids. *K. Svenska Vetenskapsakad. Handl.*, 13: 1–79.

——. 1934b. On the Placodermi of the Upper Devonian of East Greenland. I. Phyllolepida and Arthrodira. *Medd. om Grønland*, 97: 1–58.

——. 1936. On the Placodermi of the Upper Devonian of East Greenland. Supplement to Part I. *Medd. om Grønland*, 97 (2): 1–52.

——. 1937a. Notes on the endocranium of a Devonian *Cladodus*. *Bull. Geol. Inst. Univ. Upsala*, 27: 128–144.

——. 1937b. On the Devonian coelacanthids of Germany with special reference to the dermal skeleton. *K. Svenska Vetenskapsakad. Handl.*, (3) 16: 1–56.

——. 1938. Middle Devonian vertebrates from Canning Land and Wegener Peninsula (East Greenland). *Medd. om Grønland*, 96: 1–30.

——. 1939a. A new anaspid from the Upper Devonian of Scaumenac Bay in Canada, with remarks on the other anaspids. *K. Svenska Vetenskapsakad. Handl.*, (3) 18: 1–25.

——. 1939b. On the Placodermi of the Upper Devonian of East Greenland. Second supplement to Part I. *Medd. om Grønland*, 97 (3): 1–33.

——. 1942. On the snout of arthrodires. *K. Svenska Vetenskapsakad. Handl.*, (3) 20: 1–32.

——. 1944. Contributions to the knowledge of the vertebrate fauna of the Silurian and Devonian of western Podolia. II. Notes on two arthrodires from the Downtonian of Podolia. *Ark. Zool.*, 35A: 1–83.

——. 1945. On the Placodermi of the Upper Devonian of East Greenland. II. Antiarchi: Subfamily Bothriolepinae, with an attempt at a revision of the previously described species of that subfamily. *Palaeozool. Groenlandica*, 2. (In press. Not seen.)

STETSON, H. C. 1928. A restoration of the anaspid *Birkenia elegans* Traquair. *J. Geol.*, 36: 458–470.

TRAQUAIR, R. H. 1899. Report on fossil fishes collected by the Geological Survey of Scotland in the Silurian rocks of the south of Scotland. *Trans. Roy. Soc. Edinb.*, 39: 827–864.

WATSON, D. M. S. 1921. On the coelacanth fish. *Ann. Mag. Nat. Hist.*, (9) 8: 320–337.

——. 1925. The structure of certain palaeoniscids and the relationships of that group with other bony fish. *Proc. Zool. Soc. Lond.*, 1925: 815–870.

——. 1926. The evolution and origin of the Amphibia. *Philos. Trans. Roy. Soc. Lond.*, B, 214: 189–257.

——. 1928. On some points in the structure of palaeoniscid and allied fish. *Proc. Zool. Soc. Lond.*, 1928: 49–70.

——. 1934. The interpretation of arthrodires. *Proc. Zool. Soc. Lond.*, 1934: 437–464.

——. 1937. The acanthodian fishes. *Philos. Trans. Roy. Soc. Lond.*, B, 228: 49–146.

——. 1938. On *Rhamphodopsis*, a ptyctodont from the Middle Old Red Sandstone of Scotland. *Trans. Roy. Soc. Edinb.*, 59: 397–410.

——, and GILL, E. L. 1923. The structure of certain Palaeozoic Dipnoi. *Jour. Linn. Soc. Lond.*, 35: 163–216.

WEITZEL, K. 1926. *Conchopoma gadiforme* Kner, ein Lungenfisch aus dem Rotliegenden. *Abh. Senck. Naturf. Ges.*, 40: 159–178.

WESTOLL, T. S. 1936. On the structures of the dermal ethmoid shield of *Osteolepis*. *Geol. Mag.*, 73: 157–171.

——. 1937a. On the cheek bones in teleostome fishes. *J. Anat.*, 71: 362–382.

——. 1937b. On a specimen of *Eusthenopteron* from the Old Red Sandstone of Scotland. *Geol. Mag.*, 74: 507–524.

——. 1937c. The Old Red Sandstone fishes of the north of Scotland, particularly of Orkney and Shetland. *Proc. Geol. Ass. Lond.*, 48: 13–45.

——. 1938. Ancestry of the tetrapods. *Nature, Lond.*, 141: 127–128.

——. 1939. On *Spermatodus pustulosus* Cope, a coelacanth from the "Permian" of Texas. *Amer. Mus. Novit.*, 1017: 1–23.

——. 1942. The earliest panzergruppen. *Aberdeen Univ. Rev.*, 1942: 114–122.

——. 1943. The origin of the tetrapods. *Biol. Rev.*, 18: 78–98.

——. 1944. The Haplolepidae, a new family of late Carboniferous bony fishes. A study in taxonomy and evolution. *Bull. Amer. Mus. Nat. Hist.*, 83: 1–122.

WHITE, E. I. 1927. The fish-fauna of the cementstones of Foulden, Berwickshire. *Trans. Roy. Soc. Edinb.*, 55: 255–287.

——. 1935. The ostracoderm *Pteraspis* Kner and the relationships of the agnathous vertebrates. *Philos. Trans. Roy. Soc. Lond.*, 225: 381–457.

——. 1939. A new type of palaeoniscoid fish, with remarks on the evolution of the actinopterygian pectoral fins. *Proc. Zool. Soc. Lond.*, B, 109: 41–61.

WOODWARD, A. S. 1921. Observations on some extinct elasmobranch fishes. *Proc. Linn. Soc. Lond.*, 133: 29–39.

——. 1931. *Modern progress in vertebrate palaeontology*. In "Huxley Memorial Lectures 1925–1932; pp. 1–21. Macmillan Co., London.

NEW BIOLOGICAL BOOKS

The aim of this department is to give the reader brief indications of the character, the content, and the value of new books in the various fields of Biology. In addition there will frequently appear one longer critical review of a book of special significance. Authors and publishers of biological books should bear in mind that THE QUARTERLY REVIEW OF BIOLOGY *can notice in this department only such books as come to the office of the editor. The absence of a book, therefore, from the following and subsequent lists only means that we have not received it. All material for notice in this department should be addressed to B. H. Willier, Editor of* THE QUARTERLY REVIEW OF BIOLOGY, *Department of Biology, Homewood Campus, The Johns Hopkins University, Baltimore 18, Maryland, U. S. A.*

ESSENTIA NON SUNT MULTIPLICANDA PRAETER NECESSITATEM

A review of *The Biological Basis of Individuality*, by *Leo Loeb*. Charles C. Thomas, Springfield, Ill. and Baltimore, Md. $10.50. xiii + 711 pp. 1945.

By Jane Oppenheimer, Bryn Mawr College.

" 'Strange difficulties have been raised by some,' " quotes Samuel Butler from Bishop Butler, " 'concerning personal identity.' " He continues in his own words: "We regard our personality as a simple definite whole. . . . But in truth this 'we,' which looks so simple and definite, is a nebulous and indefinable aggregation of many component parts which war not a little among themselves, our perception of our existence at all being perhaps due to this very clash of warfare, as our sense of sound and light is due to the jarring of vibrations. . . . Not only is our personality as fleeting as the present moment, but the parts which compose it blend some of them so imperceptibly into, and are so inextricably linked on to, outside things which clearly form no part of our personality, that when we try to bring ourselves to book, and determine wherein we consist, or to draw a line as to where we begin or end, we find ourselves completely baffled. There is nothing but fusion and confusion."

Leo Loeb, in his impressive and important book, *The Biological Basis of Individuality*, has summarized the results of over forty years' work into an attempt to analyze that "nebulous and indefinable aggregation of many component parts . . . which war not a little among themselves" to constitute the definite whole which is the individual.

He conceives of individuality as "the original physical and psychical state of an organism, which has developed in accordance with the genetic constitution of this organism with the co-operation of a sequence of more or less fixed physical-chemical conditions." He postulates a distinction between two types of individuality, the *mosaic* type and the *essential* type; his primary aim is the investigation of the extent to which these two postulated factors participate in determining the unity of the individual organism.

The mosaic type of individuality he defines as representing the "sum of the particular organ and tissue characteristics (organ and tissue differentials) which determine structure, metabolism, motor and psychical activities and the component parts of which differ in different individuals." The organ and tissue differentials are conceived as factors inherent in organs and tissues, factors which are similar in corresponding organs and tissues of different individuals or species.

The essential type of individuality he postulates as "characterized by the presence of a chemical factor—the individuality differential—which is common to the different organs and tissues of each individual and which differs from the corresponding chemical characteristics of the organs and tissues of every other individual." There exist in addition various differentials, comparable to the individuality differentials, which distinguish species, genus, order, and class; the individuality, species, genus, order, and class differentials are all grouped together as organismal differentials. The concept of the essential individuality as determined by organismal differentials "emphasizes the oneness of the individual which depends upon the presence of a common and unique factor in all of his essential parts."

A considerable portion of the book is devoted to a meticulously detailed description of the experiments which Loeb considers as establishing the existence of such differentials. The author deals first with the results of carefully controlled experiments, performed largely in his own laboratories, involving the transplantation of normal and tumor tissues. In the case of normal tissues, the results of such experiments differ, qualitatively and quantitatively, varying with the nature of the genetic relationship of host and donor; Loeb claims, on the basis of these facts, to demonstrate the existence of the organismal differentials. Similar organismal differentials have been demon-

strated, according to Loeb, by grafting tumor tissues. These tissues are said to carry the same organismal differentials as do normal tissues, but the outcome of their transplantation differs from that of normal tissues since tumor tissues differ from normal in their "growth momentum," in their ability in some cases to adapt within the host organism, and in their capacity for eliciting immune reactions on the part of the host.

While the transplantation method has proved especially valuable to Loeb for his study of the individuality differentials, serological methods have been used by various investigators for the study of species, order, and class differentials. The author, therefore, takes up in considerable detail the relationship between organismal differentials and organ differentials as antigens.

He concludes that the individuality differentials are not identical with the common blood-group differentials nor with the Forssman heterophile antigens, nor yet with other special agglutinogens or agglutinins present in the blood of various individuals. He holds that the available observations "exclude the possibility of identification of these agglutinable factors with organismal differentials, but not the possibility that these various factors, or some of them, may be present among the individuality differentials, or, rather, that the genes representing these factors may be a component part of the gene sets which determine the individuality differentials." "However," he adds later, "it may be assumed that the greater the number of additional antigens which will be found in the erythrocytes, the less will be the difference remaining between the totality of these antigens in the erythrocytes and in the individuality differentials." "In the erythrocytes of several species," he adds further, "the presence of differentials of an individual character has been established by means of immune sera, but it has not yet been definitely proved that these differentials are identical with the individuality differentials. . . . This fact may be interpreted," he concludes in what is a masterpiece of understatement, "as indicating that complexities in the structure of blood proteins exist, which have not yet been amenable to a purely chemical analysis."

On the basis of the results of the transplantation of tissues altered by heat or by chemical treatment, and of various serological studies, Loeb discusses the possible chemical nature of the postulated differentials. He concludes that "there can be little doubt that the organismal differentials are proteins; this is indicated by their great sensitiveness to heat and to the action of substances which are known to denature proteins As to the organ, heterogenetic and blood-group differentials, proteins may enter also into their constitution, but they may still retain to a certain degree at least their characteristics as antigens under conditions in which proteins are denatured. Therefore other groups than proteins form part of these antigens. They may be conjugated proteins, combinations of proteins, acting as carriers, and of complex carbohydrates, lipids, or simpler organic substances acting as haptens."

From a consideration of all these results, Loeb arrives at the general conclusion that "the organism is, then, a harmonious whole, a combination of the mosaic and of the essential type of individuality; in it, therefore, not only the organ functions are adapted to one another, but also all the various tissues, though apparently functionally unrelated, are specifically adapted to one another, owing to the nature of their organismal differentials. . . . If, then, we may consider it an established fact that when tissues are transplanted . . . substances are given off by these tissues which will call forth noticeable reactions on the part of the host cells, might it not be possible, or even probable, that such substances . . . are also given off in the animal's own organism; but that, here, instead of operating as disturbers of the tissue equilibrium, on the contrary, they serve as instruments by means of which the tissue equilibrium is maintained and regulated in such a manner that it is best adapted to the normal cooperation of the various tissues in the interest of the entire organism, and thus to the normal functioning of the organism as a whole?"

There is no one who can take issue with Loeb's concept that delicate chemical differences distinguish one organism from another, and there are few, if any, who will dispute that such differences are somehow related to the nature of proteins or their configurations. Not every investigator will agree, however, that the specific differential substances postulated by Loeb are of proved existence, nor that their manifestation is cause rather than effect of the over-all metabolic individuality of the organism.

But whether or not such special substances act in the fashion that Loeb believes, the author has accomplished a masterpiece of critical analysis and synthesis in the construction of this volume. He has woven into the web of its texture well-chosen and accurately described data from surgery, pathology, genetics, embryology, psychology, indeed from almost every field of experimental biology. He concludes with a fifty-page section relating biological fact to philosophical theory that might well be separately reprinted, to the great benefit of many non-biologists who interest themselves in the problems of the relationship of the part to the whole and the relationship of the organism to the natural universe. The quality of Loeb's analytical thinking is superb; and his book is a monument to the unobtrusive but nonetheless profound influence which he has exerted on the course of American biology.

REVIEWS AND BRIEF NOTICES

GENERAL BIOLOGY: PHILOSOPHY AND EDUCATION

THE WAY OF AN INVESTIGATOR. *A Scientist's Experiences in Medical Research.* *By Walter Bradford Cannon. W. W. Norton and Company, New York.* $3.00. 229 pp. 1945.

The lives of few scientists have been so completely ideal and so productive of satisfactory accomplishment as was that of the author of this book. From this standpoint alone the autobiographical account of Walter Bradford Cannon's life, work, and philosophy is of great value. His scientific career was a marvel of orderliness and completeness. From its beginning it progressed by ordered steps, each enterprise leading logically to the next. Each time, before he left the old to enter newer fields, he paused to summarize, to organize results and thoughts, that he might leave for other scientists conclusions based upon a synthesis of all that he had seen. Five major fields were covered, and each time a book of facts and clear conclusions was produced which made significant contributions to the progress of physiology. In addition to all this he accepted the responsibilities of an administrator and a citizen, using his ability to maintain and strengthen his university, American science, and international good will. It is fortunate, indeed, that Cannon felt the desire and was able to write this last volume, filled with simple wisdom, which describes the way of life of an investigator; fortunate that we now possess, in addition to the results of his work, this picture of the man and his philosophy. The first four chapters are concerned with factors which he felt must be essential to the making of an investigator. The influence of heredity and early experiences in his own development are discussed in a chapter entitled "As the Twig is Bent." The essential spirit of adventure and the fitness for the enterprise are dealt with next. This is followed by a convincing and very practica' helpful analysis of those circumstances which are favorable and those which are unfavorable to the development and activities of an investigator. Chapters 5 to 9 contain a description of the ways in which investigators work: how ideas come to them, how they should work and select ideas, how they obtain their inspiration and their strength. The following three chapters are filled with advice based on experience. They describe the dangers to be avoided, methods of administration, some working principles, and the best procedure to be followed when scientists find they disagree. The last half of the book is more completely devoted to a description of personal experiences, but it too contains little essays concerning the responsibilities of an investigator as a citizen, the necessity of making science understandable, the possibilities of cooperative research, the value of friendships, doings in idleness and the fruitful years. It is difficult to select any one section to illustrate the ideals, the good humor, the intelligence and the refreshing simplicity of this man, but the amusing little story told in Chapter 17 of "A Display of Human Frailties" does illustrate the way in which Cannon always used his knowledge to guide his actions and how he employed this simple comedy of human errors as a basis for estimating the effectiveness of various elements contributing to the responses of human beings. The book is more than an autobiography; it is a volume filled with many things which can be of help to those investigators who will avail themselves of the opportunity to read the thoughts so well expressed on these few pages.

CHANDLER MCC. BROOKS

CIVILIZATION, SCIENCE AND RELIGION. *Pelican Books. By A. D. Ritchie. Penguin Books, New York.* 9 d. (paper). 188 pp. 1945.

The author is a physiologist who now holds the chair of Philosophy at Manchester University. He has written informatively and well of the birth of civilization and the origins of religion, science, and philosophy; of the rise of Christianity, the role of the Roman Church in Western civilization, and the medieval outlook; of the rise of experimental science, physical and biological, of the social sciences, and of moral principles; finally, of modern fallacies (Naturalism) and of faith. Ritchie's aim is not solely to trace the historical development of each of these, but especially to show their interrelations. As an example of his insight and pungent expression, one may quote his comment on artistic and intellectual integrity in Greek and modern times: "I believe the main difference between modern European and ancient Greek is that we moderns seldom deliberately deceive others but frequently deceive ourselves unconsciously or half-consciously, while the Greek constantly deceived others (or tried to deceive them, for lying in a nation of liars is a difficult art) but very seldom deceived himself."

The central position taken by Ritchie is that Naturalism (including Materialism, Mechanism, Positivism, and Phenomenalism) is unsound in assuming the all-sufficiency of science and the lack of any truth but scientific truth. There is also moral principle, Natural Law, and the truth of revelation. Like Romanticism, which dominated early nineteenth century thought, Naturalism became a challenge to religion only because the latter was "usually conceived in terms of external absolute authority." Historical perspective is a great corrective to the tendency to

overstress either science or religion. In present times, the author thinks, the main problem is spiritual blindness and short-sightedness. "The source of the danger is in ourselves and our false valuations; in the worship of false gods, as older writers put it. For a standard of values and a criterion to distinguish progress in civilization from regress we can look to Christian tradition only."

The chief defect in this essay is to be found in a tendency to make over-abrupt changes of thought and to reach conclusions in too summary a fashion. This is particularly apparent in the abbreviated consideration given to the evolution of ethical values, a crucial point in his line of thought. Ritchie is not altogether sound in his discussion of evolution. He talks of inherited variations in the vein of Bateson, and is apparently not cognizant of modern mutation theory. He says, for instance, that "a continual supply of favorable variations which are inherited . . . (is) a large number of little miracles." He thinks of natural selection as a purely negative factor, in no sense creative. He proposes that survival as a *value* is purely a human-value judgment, because men prefer living, as a rule, to dying; as though all other organisms, in so far as we can judge, do not also struggle to avoid dying. Moreover, to regard Julian Huxley as strengthening the arguments of his grandfather regarding the evolution of ethics is surely a gross misjudgment of one or the other. In the most fundamental points their views differ sharply. Similar shortcomings are probably seeded through other sections of the book, since it is presumably in biology that Ritchie's training has been most thorough.

Whether or not the reader will in the end agree or violently disagree with the author's conclusions, there can be no question about the stimulating, thought-provoking character of this essay. We need many more such analyses of the relations of science to other aspects of civilization. A careful and greatly enlarged consideration of the subject by Ritchie himself would be very welcome. For the meanwhile, here is rich worth for little cost.

BENTLEY GLASS

GENERAL BIOLOGY. *Revised Edition.*

By Leslie A. Kenoyer and Henry N. Goddard. Harper and Brothers, New York and London. $4.00. viii + 653 pp.; 2 plates. 1945.

The present revision of this excellent text follows much the same plan of organization and presentation of materials as the earlier edition, though numerous alterations and additions are in evidence. One notable change is seen in the use of an abundant new supply of both graphic and photographic illustrations. Another is the addition of an entirely new chapter on conservation.

The work covers a wide range of both plant and animal forms, and emphasizes the biological principles exhibited in the life activities of each form. The presentation of materials is pedagogically sound, and of sufficient flexibility to provide for a wide range of teaching methods and student abilities. The text is written in a simple yet authoritative style, and will undoubtedly hold the interest of every college student entering into his first concentrated study of biology. Each chapter is provided with a group of exercises and list of references on the work covered therein. The glossary, a complete list of references, a list of text films, and the detailed index enhance the value of the text for both classroom and reference use. The present edition unquestionably assures this fine text continued popularity in the field of textbooks of general biology.

B. AUBREY SCHNEIDER

ANIMALS AND THEIR YOUNG. (*The Basic Science Education Series*).

By Glenn O. Blough. Consultant: Bertha Morris Parker.

ANIMALS THAT LIVE TOGETHER. (*The Basic Science Education Series*).

By Glenn O. Blough. Consultant: Bertha Morris Parker.

BIRDS IN THE BIG WOODS. (*The Basic Science Education Series*).

By Glenn O. Blough. Consultant: Bertha Morris Parker.

THE PET SHOW. (*The Basic Science Education Series*).

By Glenn O. Blough. Consultant: Bertha Morris Parker.

HOW THE SUN HELPS US. (*The Basic Science Education Series*).

By Glenn O. Blough and Ida B. DePencier. Consultant: Bertha Morris Parker.

USEFUL PLANTS AND ANIMALS. (*The Basic Science Education Series*).

By Glenn O. Blough. Consultant: Bertha Morris Parker.

Row, Peterson and Company, Evanston, Illinois. 32 cents each (paper); 24 cents in quantities of 5 or more. 36 pp. each. 1945.

The first four of these booklets are for second grade readers, the last two for those in the third grade. They are all well written and most attractively illustrated.

The first two listed are perhaps better than the other two second grade booklets. The subject matter of *The Pet Show* is less distinctly introductory natural history and resembles the stories found in many school readers. The illustrations in *Birds in the Big Woods* are reproductions of color photographs, mainly from the collection of A. A. Allen. Some are excellently reproduced, but others, due to faulty register or color

values, did not come out so well. For example, white eggs are made to appear blue.

Useful Plants and Animals deals with domesticated animals; animals used for food; animals supplying wool, leather, or fur; birds that are insect, vermin, or weed seed eaters; and with plants such as shade trees, rubber trees, cotton, flax, coffee, cocoa, vegetables. It is far inferior in interest and teaching value to *How the Sun Helps Us*. The latter is really an outstanding achievement. Some of its pictures are so striking that they might well be used in more advanced books. The text describes the sun and the solar system and the relation of the sun to life on the earth in a remarkably clear and simple way. An experimental approach is introduced, in a very skilful manner.

The mature biologist should be interested in all of these booklets, as they mark a most happy progress in the science education of American youngsters. Instead of worrying about recruiting new generations of scientists at the college level, we might in the end accomplish a great deal more by paying suitable attention to the lowest levels of science education. These booklets, inexpensive, attractive, carefully planned, well written, and factually accurate, deserve to be called to the attention of all parents as well as of all teachers in the elementary grade school.

BENTLEY GLASS

NEW BIOLOGY. I.

Edited by M. L. Johnson and Michael Abercrombie. Penguin Books, London and New York. 9 d. (paper). 118 pp.; 3 charts; 4 plates. 1945.

This is Number One in a proposed series of booklets to contain authoritative biological reviews for the layman. The first issue contains: The Potato—Master or Servant? by Redcliffe N. Salaman; The Measurement of Human Survival, by Lancelot Hogben; Trace Elements in Plants, by Walter Stiles; The Functions of the Central Nervous System, by J. Z. Young; The Anatomical Basis of Sensory Experiences, by W. E. Le Gros Clark; Wireworms and War-time Agriculture, by Mary Miles; and Malaria, Mosquitoes and Man, by M. L. Johnson.

The papers differ considerably in scope and difficulty of apprehension. Contrary to the view expressed by the editors, the article by Hogben seems to me to be the hardest for a non-scientific reader to comprehend. That similar material can be written more simply has been shown, for example, by Warren Thompson, in his book *Plenty of People*. The comprehensive article on the history, nutritive values, and agriculture of the "Irish" potato is very well done and most interesting. There are four rotogravure plates of South American potato pottery. The article on trace elements in plants suffers from being too condensed; otherwise it is clear and informative. Unquestionably the two articles on the nervous system are the most valuable contributions, and many biologists will find them rewarding. The articles on wireworms and malaria are illustrated by "isotypes," a British form of pictorial statistics.

This series is a most worthy enterprise in the scientific education of the general public. All biologists will wish it a great and continuing success.

BENTLEY GLASS

GLIMPSES OF JAMAICAN NATURAL HISTORY.

By Members of the Natural History Society of Jamaica. Science Museum, Institute of Jamaica, Kingston. 1s. (paper). 84 pp. 1945.

ECOLOGY

SAVING OUR WILDLIFE. *The Basic Science Education Series.*

By Bertha Morris Parker with the collaboration of Gladys K. McCosh. Row, Peterson and Company, Evanston, Illinois. 32 cents (paper); 24 cents on orders of 5 or more. 36 pp. 1944.

For the sixth grader, this booklet introduces the subject of conservation. It begins with the stories of the extinction of the passenger pigeon and the near extinction of the American bison. The great auk, marten, grizzly bear, duck hawk, ivory-billed woodpecker, prairie dog, bobcat, moose, etc., furnish other examples. How man has affected wild life by farming the prairies, cutting down the forests, draining the swamps, polluting streams, and damming rivers is discussed; and the balance of nature and the usefulness of animals of prey is brought out clearly. Next comes an SOS for our wild plants, from sequoias to ladyslippers. This is followed by a consideration of the benefits received from wild life and the measures that must be publicly undertaken to save it. At the end there is a summary and a list of activities for the individual child to carry out. The abundant colored illustrations are very fine.

All in all, this little booklet may have much greater influence in the right direction than many a weighty textbook on conservation. At least, it is not dull.

BENTLEY GLASS

A BIOLOGICAL SURVEY OF MOOSEHEAD LAKE AND HAYMOCK LAKE, MAINE. *Fish Survey Report No. 6.*

By Gerald P. Ciioer and John L. Fuller. Maine Department of Inland Fisheries and Game, Augusta. (Paper). vii + 160 pp.; 1 map. 1945.

This is the sixth in a series of reports on the lakes in Maine. Moosehead Lake is the largest in the State

and one of its most famous fishing grounds. Conversely, Haymock Lake is relatively inaccessible and was studied to afford comparative data between a well-fished, repeatedly stocked lake and one that has been virtually undisturbed by man.

Physical and chemical characteristics of the water, and analyses of samples of the fish, plankton, and bottom dwellers were included in the survey. The evidence indicates that Moosehead Lake could support a larger population of salmonids (trout, togue, salmon). Smelts act as intermediaries in the food chain between the animal plankton and the salmonids, and it is argued that more smelt of the right size would increase the salmonid population. Although the detailed ramifications of the smelt-salmonid relationship are too involved to discuss further in this review, the writers examine all the possible predictable results.

Legal size limits for the three game fish are too small, for it was found that they do not reach maturity until they are three or four inches above the limits, or in other words, until after another year's growth. Several other recommendations are made. A large map of Moosehead Lake, showing soundings and geographic localities, is included in the inset and may be obtained separately.

HENRI C. SEIBERT

THE ECOLOGY OF THE PRAIRIE CHICKEN IN MISSOURI. *The University of Missouri Studies, Volume XX, No. 1. By Charles W. Schwartz. University of Missouri, Columbia, Mo.* $1.50 (paper). 99 pp.; 16 plates; 9 maps. 1945.

The prairie chicken existed formerly in every prairie county of Missouri, but now occupies only about 2500 square miles in the northeastern, north central, and southwestern parts of the State. The present distribution has been limited by current land-use practices in the permanent grasslands. Late mowing, promiscuous burning, and overgrazing have had unfavorable effects, but no shortage of food on any of the inhabited ranges was found to exist.

In making population studies the writer found it best to count the males on the booming grounds; knowing the sex ratio, the total population could subsequently be determined. The data from Missouri agree reasonably well with population trends from other areas and indicate a nine year cycle. For the entire state the peak estimate was 13,000 birds in 1941, declining to 9250 in 1944.

Natural history data on the interesting courting activities of the males on the booming grounds, the behavior of females, nesting, roosting, and flocking habits are all based on original observations. Indications are that males of the year join their elders on the fall booming grounds, and that territories are maintained from spring to fall. Food habits and causes of mortality are discussed, although little positive information is offered for the latter.

This study is concluded by recommending management policies regarded as favorable for the continued preservation of the species. These include continuation of legal protection, controlling overgrazing, late mowing and burning, and provision of permanent water supplies. The illustrations are excellent and, with the exception of five, are different from those appearing in *The Prairie Chicken in Missouri*, the writer's former publication that consisted entirely of photographs and short legends. Eight detailed sectional maps show the present distribution of known flocks.

Much useful information and many valuable suggestions are contained in this report, and it is to be hoped that investigations of this sort will be relied upon to improve the fate of this country's grassland game birds.

HENRI C. SEIBERT

OBSERVATIONS AND RESULTS IN PHYSICAL OCEANOGRAPHY. *Scientific Results of Cruise VII of the Carnegie during 1928–1929 under Command of Captain J. P. Ault. Oceanography—I-B. Department of Terrestrial Magnetism, Carnegie Institution of Washington Publication 545.*

By J. A. Fleming, C. C. Ennis, H. U. Sverdrup, S. L. Seaton, and W. C. Hendrix. Carnegie Institution of Washington, Washington. $2.00 (cloth); $1.50 (paper). iv + 315 pp. 1945.

This volume assembles the graphs, figures, and tables of the oceanographic data for cruise VII of the Carnegie, for ready cross-reference in studying other volumes of the series.

SEASONAL OCCURRENCE OF MARINE PLANKTON DIATOMS OFF SOUTHERN CALIFORNIA IN 1938. *Bulletin of the Scripps Institution of Oceanography of the University of California, Vol. 5, No. 3.*

By W. E. Allen. University of California Press, Berkeley and Los Angeles. 50 cents (paper). Pp. 293–334. 1945.

EVOLUTION

CLIMBING OUR FAMILY TREE. *A Young World Book. By Alex Novikoff. Illustrated by John English. International Publishers Company, New York.* $1.85. 96 pp. 1945.

It would indeed be difficult to praise such a book as this account of evolution for the ten or twelve year old

too highly, particularly since there has been nothing of its kind before. Whether one considers the illustrations, numerous and sketched in color or black and white with accuracy and humor by the author; or whether one considers the text, a compact, clearly written, accurate account of both the course and the causes of evolution—one can only express enthusiasm. Having tried it out personally on my ten-year-old daughter, I can report that she was as interested and excited by it as her father. The author is hereby nominated for the award given for the best children's book of the year.

BENTLEY GLASS

EARLY UPPER CAMBRIAN FAUNAS OF CENTRAL MONTANA. *Geological Society of America Special Papers, Number 54.*

By Christina Lochman and Donald Duncan. The Geological Society of America, New York. $1.50 (paper). ix + 181 pp.; 19 plates. 1944.

"This paper is the first part of an Upper Cambrian faunal study designed to supplement Deiss' stratigraphic work on the revision of the type Cambrian formations and sections of central Montana . . . Four genera and three new species are described from the *Aphelaspis* zone; 26 genera (4 new) and 42 species (32 and 2 varieties new) from the *Crepicephalus* zone; and 38 genera (5 new) and 70 species (43 and 1 variety new) from the *Cedaria* zone."

Lochman and Duncan state that "though the number of genera and species described may seem large; this work is far from exhaustive" and "A complete paleontologic study of each faunal assemblage . . . would undoubtedly double or triple the size of the faunas."

"Emphasis is placed primarily upon the stratigraphic side with a view to obtaining the correct correlation of the central Montana formations with the standard Upper Cambrian section," and the first 41 pages of the report are concerned with a summary statement of the problem and the results obtained.

The individual systematic descriptions, which comprise the bulk of the report, are a model of organization and succinctly stated detail. However, the absence of measurements is surprising, and the omission of reference to previously described genera for which species are described may be a source of annoyance to those unversed in trilobite taxonomy. References to suprageneric categories are not consistent, in some instances omitting the date, and in others both author and date. A novel feature is the system of individually crediting new systematic units described, new species, genera, etc. being credited to Lochman or to Duncan and only rarely to both.

Although the full-tone photographic illustrations of the fossils described by Lochman and Duncan are probably better than average, some of them are not sharply focussed, and many of them lack depth. In the preparation of illustrations for full-tone reproduction, it is a common error to overlight the lower right-hand side of the specimen in an effort to bring out shadow detail.

W. Charles Bell's short section, entitled "Early Upper Cambrian Brachiopods," (pp. 144–153, Pls. 18–19) deserves special notice. His concise descriptions of 7 species (4 new) in 6 genera (1 new) are supplemented by outstandingly fine photographs. When one considers that all of the photographs are magnified at least 5 diameters and some 10 diameters, their sharp focus, clarity of detail, and general "tone" cannot fail to elicit admiration.

PRESTON E. CLOUD, JR.

THE CENOZOIC BRACHIOPODA OF WESTERN NORTH AMERICA. *Publications of the University of California at Los Angeles in Mathematical and Physical Sciences, Volume 3.*

By Leo George Hertlein and U. S. Grant IV. University of California Press, Berkeley and Los Angeles. $3.00 (paper). vi + 236 pp.; 21 plates. 1944.

Although concerning itself primarily with the previously published record and the task of bringing it together in a single volume, this publication also includes descriptions of 3 new genera and 19 new species and subspecies of Cenozoic brachiopods. It considers 76 specific and 31 generic categories of western American Cenozoic and Cretaceous brachiopods, and groups them in 6 families. Of these, 19 species and 4 genera are inarticulates, and 57 species and 27 genera are articulates; and of the latter, 45 species and 19 genera are terebratuloids. Keys are provided to the species of the two most diversified genera, *Discinisca* and *Terebratalia*.

The bulk of the publication (pp. 10–172) consists of systematic records and descriptive matter. Except for the descriptions of the new forms, which are more or less conventionalized, it is comprised mostly of citations of, direct quotations from, or paraphrases of the previously published record, all scrupulously credited. Little attempt, however, is made to present new, or to coordinate the known, biologic data.

The general organization of the discussions of previously described genera and species emphasizes the historical record, the original source and orthography of the name, and the locality and geologic age or the habitat of the specimens represented by the various reports cited. It seems to have been the intention of Hertlein and Grant to produce an exhaustive, illustrated, and annotated check list, and they have brought together a vast amount of interesting historical and ecological data. The difficult problem of presenting so much detail in a well organized and usable

manner is not entirely solved by the present report, but the information is there, and no one interested in the Recent or Cenozoic brachiopoda can afford to be without it.

The critical reader may question whether some of the conclusions stated are supported by the evidence cited. Rather than emphasizing a similarity between Miocene and Recent brachiopod faunas, the faunal lists presented on pages 7 to 9 of Hertlein and Grant's report, assuming that the collections on which they are based are representative, suggest that a rather uniformly progressive change in aspect of the western American Cenozoic brachiopod faunas was interrupted only during Pleistocene time, probably by migration of the isotherms, and hence of the stenothermal species. It may also be suggested that the evidence cited with reference to the genotype of *Terebratulina* appears to indicate that the designated genotype was *Anomia caput-serpentis* Linnaeus 1767 (not 1758) = *A. retusa* Linnaeus 1758, and that a ruling of the International Commission on Zoological Nomenclature is not required to fix *A. retusa* as the genotype of *Terebratulina*.

The new genera bear suggestive names (*Eohemithiris, Eogryphus, Miogryphus*); but little information is given concerning their internal features, and the illustrations furnished are not an adequate basis from which to judge their relationships.

The book is copiously illustrated by a total of 463 individual illustrations, an average of 6 to each of the 76 species considered. Of these, however, only 48 are internal views, and only 27 of the 48 are original. Of the 74 named species and subspecies considered, internal views are furnished for 23; and of the 46 named terebratuloid species, the loops are figured for only 11. By some inexplicable oversight, a loop is not figured for the common and beautiful west coast terebratuloid, *Laqueus californianus* Koch.

The text figures are, as a whole, very nicely done, and the two credited to the pen of E. H. Quayle are excellent; but there is room for improvement in the full-tone plate figures.

For the preparation of this exhaustive compendium Hertlein and Grant deserve the thanks of all interested in the Brachiopoda, to which the reviewer adds his earnest hope that the authors will follow the present report with a critical biological study of their collections and a systematic appraisal of the ecological data.

PRESTON E. CLOUD, JR.

CHECK LIST OF CALIFORNIA TERTIARY MARINE MOLLUSCA. *Geological Society of America Special Papers, Number 56.*

By A. Myra Keen and Herdis Bentson. The Geological Society of America, New York. $1.85 (paper). viii + 280 pp. 1944.

This thoroughly documented and well-indexed catalog will be indispensable to Tertiary invertebrate paleontologists, particularly to those working on molluscan faunas from the Pacific coast of North America. The entries are restricted to records documented by illustrations. This restriction considerably diminished the amount of labor in compilation, but also diminished the usefulness of the catalog. By excluding nonmarine and Pleistocene mollusks, the authors imposed upon themselves the obligation to reach decisions concerning the probable habitat of some species and concerning the disputed boundary between the Tertiary and Pleistocene.

W. P. WOODRING

MESOZOIC AND CENOZOIC ARCIDAE FROM THE PACIFIC SLOPE OF NORTH AMERICA. *Geological Society of America Special Papers, Number 47.*

By Phillip W. Reinhart. Geological Society of America, New York. $1.25 (paper). xi + 117 pp.; 15 plates. 1943.

Fossil and Recent species of the molluscan family Arcidae from the Pacific coast of North America are described in this report. The fossil species, which range in age from Upper Cretaceous to Pleistocene, and some of the Recent species are illustrated. On the Pacific coast the northern limit of the family is now much farther south than it was during Upper Cretaceous and Tertiary time. The treatment is purely systematic. The morphologic data and age assignments will be useful in identifying and dating fossil ark shells from the Pacific coast.

W. P. WOODRING

RADIOLARIA FROM UPPER CRETACEOUS OF MIDDLE CALIFORNIA. *Geological Society of America Special Papers, Number 57.*

By Arthur S. Campbell and Bruce L. Clark. The Geological Society of America, New York. 60 cents (paper). viii + 61 pp.; 8 plates. 1944.

EOCENE RADIOLARIAN FAUNAS FROM THE MT. DIABLO AREA, CALIFORNIA. *Geological Society of America Special Papers, Number 39.*

By Bruce L. Clark and Arthur S. Campbell. The Geological Society of America, New York. 85 cents (paper). vii + 112 pp.; 9 plates. 1942.

MIOCENE RADIOLARIAN FAUNAS FROM SOUTHERN CALIFORNIA. *Geological Society of America Special Papers, Number 51.*

By Arthur S. Campbell and Bruce L. Clark. The Geological Society of America, New York. 70 cents (paper). vii + 76 pp.; 7 plates. 1944.

RADIOLARIA FROM THE KREYENHAGEN FORMATION NEAR LOS BANOS, CALIFORNIA. *Geological Society of America Memoir 10.*

By Bruce L. Clark and Arthur S. Campbell. Geological Society of America, New York. \$1.00. 66 pp.; 7 plates. 1945.

These four papers open a virtually virgin field—the description of the fossil radiolarian faunas of North America. A discouragingly large number of species from each locality are described as new. Owing presumably to the provincial character of the California faunas, their relations to faunas of the same age in other parts of the world are not discussed. Inferred paleoecology is briefly considered. The photographs illustrating the species are superb.

W. P. WOODRING

VERTEBRATE PALEONTOLOGY. *Second Edition. By Alfred Sherwood Romer. University of Chicago Press, Chicago.* \$7.50. viii + 687 pp. 1945.

The appearance of a thorough revision of a textbook indicates that a text was seriously needed in its field and that this particular book has filled the need. This is all the more striking when the subject is advanced and technical and is followed by a relatively small number of specialists. These specialists are particularly grateful for Romer's excellent work, but they are so few that their demands could hardly have supported the expense of issuing a revision. This new edition is evidence of an increasing interest in the data of vertebrate paleontology on the part of students of geology and zoology in general, and of appreciation that Romer's book presents these data in convenient, interesting, and authentic form.

English-speaking students were poorly provided with summaries of vertebrate paleontology on a professional level before the first edition of Romer's *Vertebrate Paleontology* in 1933. The two-volume translation of the vertebrate part of Zittel's *Grundzüge* was useful, but it is an excessively dull compilation, repellent even to the specialist, and was definitely out of date when issued (1932 and 1925, respectively, for the last editions of the two volumes). Smith Woodward's *Outlines of Vertebrate Paleontology for Students of Zoology* was an excellent work and was abreast or in advance of the field when published in 1898, but knowledge of the subject has been revolutionized since that date, and unfortunately Smith Woodward devoted his later efforts to the Zittel translation instead of revising his own more widely useful book.

Although Romer's text was, of course, an entirely new production, it was written much in the spirit of Smith Woodward's classic and served, in a sense, as a greatly expanded and thoroughly modernized version of that older text. The approach was that of systematic zoology, and the data were almost exclusively those of morphology, phylogeny, and taxonomy in a rather narrow sense. Some highly important aspects of vertebrate paleontology were thus omitted altogether, but the limitation was valid and the most basic facts in this field were presented. The one really serious criticism of Romer's first edition was that it gave no adequate idea of faunal sequence and was deficient in a sense of geologic time and history, which is perhaps the greatest contribution of paleontology to biology.

This deficiency has been almost entirely made up in the revised edition by the addition of three wholly new chapters (65 pages) on vertebrate history, written in the same masterly way as the rest of the book, which presents a remarkable amount of detail without ever being dull or difficult and without ever losing sight of the broader outlines. All the chapters of the first edition have been extensively rewritten and some of them subdivided, so that there are now twenty-nine chapters in place of the original twenty-three. The number of pages has been increased from 491 to 687, and the illustrations from 359 to 377.

As Romer remarks in his new preface, the decade of the 1930's was the most productive period in the history of vertebrate paleontology. In spite of the burden thus imposed, no important discovery or publication of this period has escaped attention. The revision has not, as is so likely to be true in such cases, been a mere matter of correcting errors and adding a few modern touches. The new edition is as completely up to date as if it were a new work written in 1945. It is a really remarkable feat to have treated the whole subject, even those parts most remote from Romer's personal specialty, in a way thoroughly acceptable and excellently balanced throughout.

A special feature of the new edition is the expansion of the formal classification to include all groups of family or higher rank, whether living or fossil, and all genera that are known as fossils. In conjunction with a thorough index, this is an invaluable reference for the student and working tool for the specialist. The arrangement of the classification has also been somewhat modified and, in this reviewer's opinion, much improved. It is, in general, excellent. Of course there are a few definite errors and many points are open to dispute, but it would serve no useful purpose to list these here and they are not such as seriously to detract from the usefulness of the classification.

The new edition, entirely reset, is physically attractive and well-made except for the poor quality of the paper, doubtless an aftermath of the war. The text is in excellently legible type, but the type used for the index is painfully small. Probably this is an editorial economy, although hard to reconcile with the high price of the volume, a price that will greatly reduce circulation of the book among students who should have it in their personal libraries.

This fine work is recommended without reservation to everyone who has any interest at all in fossil vertebrates.

G. G. SIMPSON

THE MAMMALIA OF THE DUCHESNE RIVER OLIGOCENE. *Transactions of the American Philosophical Society held at Philadelphia for Promoting Useful Knowledge, New Series—Volume XXXIV, Part III.*

By William B. Scott. The American Philosophical Society, Philadelphia. $2.25 (paper). Pp. 209–253; 8 plates. 1945.

Professor Scott, in friendly conversation, has remarked that consideration of the writer's age in a criticism of scientific work is as inappropriate in the case of a professor emeritus as in the case of a child prodigy. In either case, the work must stand for itself and allowance for the author's years is not pertinent, or is even impertinent. Yet it is a heartening thing, and one that cannot be excluded from a reviewer's mind, to observe that a colleague rich in years and in wisdom is still producing voluminous research—research that does, indeed, stand on its own unqualified merits.

Scott proposed a few years ago to monograph two of the largest and most important fossil mammalian faunas of North America, those of the White River group, our classical Oligocene, and of the Uinta formation, our classical upper Eocene. The White River monograph, in five large parts, was completed in 1941. The Uinta monograph is virtually completed and early publication is scheduled. In the meantime, the smaller monograph here under consideration has been issued as, in a sense, a parenthesis of considerable proportions between the two main divisions of the whole heroic project. The Duchesne River formation and fauna are intermediate in age between the Uinta and the White River and, as will be noted, there is some question as to which way their closer affinities lie.

The Duchesne River fauna is rather small, with 26 genera and species according to Scott's enumeration, several not exactly identified. The descriptions of the members of this scanty but important fauna have been widely scattered and Scott's first service is in assembling and quoting the pertinent diagnoses, with brief additions and judiciously critical remarks. Clear and artistic new figures by R. Bruce Horsfall are provided for 16 of the Duchesnean genera and species.

In restudying the available specimens, Scott found two new genera and four new species, here named and described. The new genera are *Eosictis* and *Megalamynodon*, the latter by H. E. Wood 2nd, with additional comments by Scott. The new species are *Eosictis avinoffi*, *Megalamynodon regalis* (by Wood), *Diplobunops crassus*, and *Protoreodon tardus*. Of these, the most noteworthy is *Eosictis*, based on a tantalizing fragment that suggests a peculiar sort of sabertooth cat but that is insufficient to prove that this is its true nature. If this indication does prove to be correct, so early an occurrence of this specialized group will be of unusual interest.

Both in general composition and in detailed zoological affinities, the fauna is intermediate between that typical of the late Eocene and that typical of the early Oligocene. It neatly fills what had been one of the major gaps in the American Tertiary sequence, and this gives it an interest out of proportion to the relatively scanty and usually poorly preserved fossils so far known. Scott well demonstrates and evaluates this transitional nature of the fauna. There has hitherto been some disagreement as to whether to call it Eocene or Oligocene. Scott strongly supports assignment to the Oligocene and for the first time musters the arguments in favor of this view. The question is largely one of drawing an arbitrary line, and Scott's authority is in itself strong reason for following his decision, but this reviewer feels that assignment to the Eocene would be more natural and convenient. The point is being discussed elsewhere (in press, American Journal of Science), and need not be stressed here.

To add that this publication is a model of concise, accurate observation and of trenchant, well-phrased comment, is only to repeat that it is another typical contribution from W. B. Scott. It is not age that makes him dean of American vertebrate paleontologists, but the uniformly high standards that he sets for the rest of us to emulate.

G. G. SIMPSON

GENETICS AND CYTOLOGY

GENETICS.

By Edgar Altenburg. Henry Holt and Company, New York. $3.20. xii + 452 pp. 1945.

In general, Altenburg's book is a good addition to the available texts in genetics. As might be inferred, it is a more advanced book than the author's previous *How We Inherit*. The general plan and arrangement of material is excellent. The description of chromosome behavior in the first chapter lays a foundation for much of what follows. The subjects covered are about those to be expected in an elementary text. At the end of each chapter there is a very helpful summary and a set of, on the whole, well constructed problems.

The book is very simply and, for the most part, clearly written and should be readily understood by even the poorer students. However, the attempt to achieve simplicity has led in a number of places to needlessly long explanations. Indeed in some places this has resulted in an obscuring of the main points by the explanations. Considerable space could have been saved by more concise statement with, if anything, a gain in clarity; and this space could well have been used in expanding the treatment of some of the more advanced subjects.

As such, it seems rather academic in its general outlook, on the one hand, and on the other it is, at least occasionally, inaccurate or misleading in its treatment

of particular points. (An example of the latter is the unfortunate choice of backbone versus notochord as if strictly homologous and therefore mutually exclusive, in a discussion of the genetic determination of "fundamental" traits.)

The idea that scientists should feel some responsibility for the uses to which their findings are put is becoming almost a commonplace, thanks to the advent of the atomic bomb. Geneticists, indeed, have been faced for some years with the abuse of genetic concepts in "racial" theories, and many of them were ready to meet the challenge. The positive side of this responsibility, for the proper use of knowledge, is no less important than the negative, for the prevention of its abuse. One of the fields in which genetics can properly be used is that of medicine; but, as a genetics course is not an established part of the medical school curriculum, there is at present a general need for some emphasis on human genetics in undergraduate genetics courses, unless a special course is given for pre-medical students. The epithet "academic" is applied to this book on the grounds that it fails to give adequate weight to this important aspect of genetics, so that its usefulness is restricted. Rather few examples are drawn from human genetics, and in fact the book is based very largely on the genetics of *Drosophila*, although many other organisms are brought in briefly. Particularly valuable would be more complete discussions of the special methods employed in the study of human genetics and the possible practical applications to human problems. The latter is entirely inadequately discussed to give any understanding of the possibilities or limitations along this line. The material on man is distributed throughout the book rather than gathered together in a single section. This is a good arrangement, since it serves to emphasize that the same basic principles apply to man as to other organisms.

To the reviewers the presentation of major theories (such as the chromosome theory of heredity or the theory of evolution) as cut-and-dried facts also robs the book of a part of its value and interest as the text for an advanced course. It seems preferable in such a course to cultivate an appreciation of scientific method by focussing attention on the actual steps by which such theories have been built up, leading up to the theory inductively rather than stating it as a premise.

There are two rather important omissions in the book. No references for supplementary reading are given. The stimulation of the better student to further exploration is certainly of sufficient importance to warrant their inclusion. The second is the lack of a discussion of the statistical treatment of data. In fact there is nothing more than a brief mention of probability and chance deviation. Since Genetics is frequently the only course in college where the student applies quantitative methods in biology, this omission seems most unfortunate.

The book covers the field of cytogenetics rather thoroughly, but the last two chapters dealing with heredity and development and with evolution are all too brief. The chapter on development is to a large extent taken up with a discussion of the results of experimental embryology, and only very brief consideration is given the results of physiological genetics. Certainly the former should be included, but the latter could be more fully treated and this chapter used to tie together the material on gene action scattered in other parts of the book. The chapter on the genetic basis of evolution is good as far as it goes, but it might well have been expanded, with the inclusion of more examples along with the purely theoretical discussion.

In a short chapter on the genetical interpretation of sex, the author discusses the phenomenon of "senescence" in the ciliate protozoa. The whole discussion is based on a confusion between the temporary reduction in fission rate accompanying nuclear reorganization processes such as conjugation and the slow decline in fission rate which has been established as occurring, under some conditions at least, in the absence of such processes.

The method of symbolizing used throughout the book is that employed for *Drosophila*. This leads the author to introduce symbols for other species different from those commonly accepted by workers with those species. Such arbitrary changing of symbols can only result in confusion. Furthermore the author is not himself consistent, since, for example, on page 244 he employs a set of symbols for the alleles of the agouti series in mice which are not in accord with any system of symbolizing.

In conclusion, and despite these criticisms, this book is to be considered a good addition to the texts in this field. Certainly, it could be used with much satisfaction in most elementary courses in genetics.

R. F. KIMBALL
EILEEN S. GERSH

L'HÉRÉDITÉ ET L'HOMME. *Collection "France Forever."*

By Jacques Rousseau. Les Éditions De L'Arbre, Montreal. $1.50 (paper). 250 pp. 1945.

Rousseau has given the French Canadians a book which is to some extent a counterpart of Scheinfeld's *You and Heredity*. Although it lacks the graphic diagrams of the latter, it achieves a raciness of style which should make it very readable to the layman. The principles of heredity are presented briefly but with admirable clarity, and known or suspected genetic differences in man are catalogued and discussed.

In the case of some of the more doubtfully hereditary traits, the discussion is a little too summary, as, for instance, when nomadism is neatly pigeon-holed as a recessive sex-linked character, without mention of

evidence or reference to the original source for this conclusion. It is true, however, that the author himself is aware of the disadvantages of brevity, and apologizes in the introduction for statements which may seem too dogmatic. The treatment of race and eugenics is sound, and in dealing with the latter subject the author has related his discussion very closely to the outlook of his prospective readers, who will presumably be drawn chiefly from the ranks of the Catholic Church.

EILEEN S. GERSH

THE DISCOVERY OF THE USES OF COLOURING AGENTS IN BIOLOGICAL MICRO-TECHNIQUE. *Monographs of the Quekett Microscopical Club.*

By John R. Baker. Williams and Norgate, London. 1s. 6d. (paper). 22 pp. 1945.

This is a very interesting historical monograph on the discovery of biological staining. The author divides the techniques into six groups: non-vital dyeing; vital coloring of pre-existent structures; histochemical tests; impregnation with opaque substances; coloring by phagocytosis; and injection of colored substances. The history of each of these is discussed separately.

GENERAL AND SYSTEMATIC BOTANY

AIDS TO BOTANY. *Second Edition.*

By H. J. Bonham. Bailliere, Tindall and Cox, London; Williams & Wilkins Company. $1.75. viii + 215 pp.; 1 table. 1944.

This little book, uniform with other volumes in the Students' Aids Series, has been modelled—as the author explains in the preface to the first edition—on the syllabuses of examinations normally taken in the Sixth Form of schools, or at the end of the first year at Universities and Colleges in Great Britain. Intended as a complete review course in preparation for these examinations, the book is a very brief but remarkably adequate presentation of the fundamentals of botanical science, giving in summarized—occasionally tabulated—form much of the basic material generally included in introductory courses in Botany at the college level.

There is less elaborate illustrative and photographic material than generally appears in such texts, but the diagrams and figures included are clear and informative, and diagrammatic representations of metabolic processes and nature cycles, as well as the pictorial life-histories of important evolutionary types, are original, and some of them very clever. Topics dealt with include: Distinctive Characteristics and Organization of Living Matter; Survey of the Plant Kingdom (12 chapters); Seeds and Germination; the Structure and Physiology of Roots, Stems, and Leaves; various aspects of Reproduction; Plant Ecology; Heredity and Evolution. According to the author, the brief sections on Plant Physiology have emphasized quantitative rather than qualitative aspects.

LADEMA M. LANGDON

PLANTS AND PLANT SCIENCE IN LATIN AMERICA. *A New Series of Plant Science Books, Volume XVI.*

Edited by Frans Verdoorn. The Chronica Botanica Company, Waltham, Mass.; G. E. Stechert and Company, New York. $6.00. xl + 384 pp. + 20 plates. 1945.

George Bernard Shaw with characteristic whimsy once remarked: "I tried to do too much and did it." The remark is an apt comment upon the present volume. Verdoorn embarked upon a monumental task when he undertook to bring together in one volume authoritative information upon all aspects of plant resources and plant sciences in Latin America. That he has succeeded beyond the most sanguine hopes and expectations of his botanical colleagues is a commentary not only upon his own energy, enthusiasm, and vision, but also upon the proficiency and competence of the numerous collaborators whom he chose to aid him in the task.

The book begins with an introductory essay by the Editor on "The Plant Scientist in the World's Turmoils" which is an eloquent plea for international cooperation in science and a discussion of the means for attaining it. The remainder of the book is largely devoted to articles by collaborators. Some of these are general in scope; others deal specifically with the flora and plant resources of the various countries represented. The majority of the articles are written in English, the remainder being predominantly in Spanish, with several in Portuguese or French.

It is scarcely to be expected that all of the articles in a compendium of this kind would be equally good, and indeed they are not. Some of the material in the book is definitely dated and will soon become obsolete. Much of it, however, is timeless and will be as authoritative and interesting twenty-five or fifty years hence as it is now. The general average for the entire book is high. Especially outstanding are "Some Problems of Tropical American Agriculture" by Popenoe, and "A Phytogeographic Sketch of Latin America" by Smith and Johnston. These two articles begin the volume proper with broad reconnaissances which prepare the reader for much that follows. Pennell's "Historical Sketch" will undoubtedly be used as a reference on the subject of early botanical explorations in America for many years to come. Fosberg's "Principal Economic Plants of Tropical America" is a text-book in miniature on economic botany. A reader knowing nothing of ethno-

botany will have had an ample introduction to the subject and a rich bibliography at his command when he has completed Hill's "Ethnobotany of Latin America." Marley's "Fat and Oil Resources of Latin America" is a brief but comprehensive treatise on these critically important plant products.

Especially valuable are the numerous comprehensive bibliographies which accompany the articles, and supplementing these are two introductory bibliographies one of which comprises a selected list of travel books of botanical interest. The book is indispensable from the standpoint of bibliography alone.

The treatise is illustrated with thirty-eight plates, many of them reproductions of the fascinating illustrations found in various nineteenth century volumes of botanical exploration. In addition there are fifty-odd text figures, most of which are maps, many of them original.

There is an index of personal names, but there is no subject index since, as the Editor explains, it was not feasible to prepare a subject index for so polyglot a volume. In its place there is a complete and detailed table of contents at the end of the book, which is supplemented by a summary of contents at the beginning.

The only real fault to be found with this book is its arrangement of subject matter, which follows no easily discernible pattern. The book is divided into two parts, for no apparent reason except that most (though not all) of the articles in the first half make their first appearance in print in this volume, while most (but not all) of the articles in the second part have previously been published in *Chronica Botanica*. Within each part both general articles and articles concerned with specific regions are included. There is, too, a certain amount of repetition, some of which by the very nature of the subject matter and its treatment is unavoidable.

These are minor faults which are more than compensated for by the wealth and general excellence of the material which the book contains. No American botanist (and here I include American botanists of both hemispheres) can well afford to be without this book or to have ready access to it. American botany will forever be deeply indebted to Verdoorn not only for his part in a monumental contribution to botany but also for the splendid example which he has set of scientific "good neighborliness."

PAUL C. MANGELSDORF

FLORA OF ILLINOIS, *Containing keys for the identification of the following plants and ferns. American Midland Naturalist Monograph No. 2.*

By George Neville Jones. The American Midland Naturalist, University of Notre Dame, Notre Dame, Indiana. $4.00. 317 pp.; 2 maps. 1945.

The new *Flora of Illinois* by G. N. Jones is intended as a concise working key for the identification of the ferns, fern allies, and flowering plants of the state. It is obviously not a critical monographic floristic treatment, but rather a field key designed to encourage the further accumulation of floristic knowledge in the region. The book is small enough to be carried about easily, and is attractively and usefully bound in a waterproof cover. It should prove especially useful to students and amateurs, and will supply also a source of ready reference to botanists generally for the vascular plants of Illinois.

The book begins with a brief introduction, which indicates the sources of data used, and includes a general account of the flora and vegetation of the state. Here also is a statistical summary of the taxonomic units treated—152 families, 716 genera, and 2124 species. The principal vegetational divisions are outlined after the scheme laid down in A. G. Vestal's map of 1930. This map is reproduced at the beginning of the book. The manual is based very largely upon material located in the herbarium of the University of Illinois. No doubt the total list could have been enlarged somewhat by more extensive reference to other herbaria, but for the purposes to which the book is assigned, the material base used is probably sufficient. The keys are concise and brief, beginning with a comprehensive key to the families. Within the text itself, the names of the plants are followed by brief notes on habitat, frequency, and flowering time. Diagnostic description is limited to the keys, except in a few cases where variability in characters is pointed out. Common names are included if they are available for the region. Actual specimens are not cited except for rare plants. Synonymy is reduced to a minimum, only those synonyms being included which will make the book referable to existing standard manuals. The arrangement of families is essentially that of the Engler and Prantl system.

At the close of the book are a glossary, a bibliography of the most important taxonomic articles dealing with the vascular plants of Illinois, a list of taxonomic monographs and revisions useful in studying the plants of the state, an author index, and an index to plant names, both common and scientific. The list of taxonomic monographs and revisions dealing with the seed plants is arranged in an alphabetical order of families, and that for the ferns and fern allies in an alphabetical list of authors.

It is impossible for me to criticize the actual content of the list of species which are included as growing spontaneously in Illinois. No doubt such criticism is possible, and will develop as time goes on and the list comes into actual use. There is also no doubt that the author will welcome additions and corrections as they are made, and the number of them will be a rough index of the success of the book, for it will give

some indication of the extent to which it is being used and is achieving its basic purpose.

Jones has chosen to eliminate in large measure the concepts of minor categories within species. Varieties and forms are either reduced outright or raised to specific rank. The wisdom of doing this is open to question in the light of the avowed purpose of the book. The principal idea in any flora is that of the species. Closely allied to it is the subsidiary idea of relationship. If a floristic study is to serve its complete educational purpose, it should give every assistance to the student who is trying to form a useful concept of species and a working notion of relationships. Species in nature do not differ from one another with equal clarity, thus giving rise to a great deal of the difficulty in the science of taxonomy. We can dodge this issue by disregarding in one way or another the interspecific entities. Or we can turn the difficulty around and make it useful in achieving a concept of relationship. This concept can be reached not only by using family and generic groups, but by means of species complexes as well.

HUGH M. RAUP

THE FLORA OF OAKLAND COUNTY, MICHIGAN. *A Study in Physiographic Plant Ecology. Bulletin No. 22. By Majorie T. Bingham. Cranbrook Institute of Science, Bloomfield Hills, Michigan.* $1.00 (paper). 155 pp.; 2 maps. 1945.

Oakland County, for the benefit of those who are unfamiliar with the geography of Michigan, is in the southeastern part of the state, a short distance northwest of Detroit. It contains the city of Pontiac. The present paper bears the subtitle, "A study in physiographic plant ecology," and I believe it has a rightful place among the small group of similar papers which laid the foundations, many years ago, of physiographic ecology in our Middle West. The field work upon which it is based was begun in the summer of 1934 and continued until 1941. "First a general survey was made to determine topography, soil, drainage, and typical plant communities. To make this general survey, the entire length of every road in the county was traversed, each of the 900 sections was studied in detail, and observations were recorded. . . . One hundred sixty-seven collecting stations were established to study several representative plant communities of each type in detail. . . . A full collection of the county's plants was made and is filed in the herbarium of the Cranbrook Institute of Science."

In broad outline, the paper consists of three parts: first, a general description of the "fundament"; second, a detailed discussion of the existing types of vegetation; and third, an annotated list of the vascular flora of the county. There are adequate accounts of topography, geologic history (with particular reference to the Pleistocene), climate, and soils. An especially interesting section is devoted to an estimate of the original vegetation. Plant communities are described as subdivisions of the following main categories: lake shores, swamps and marshes, bogs, streamsides, meadows, forests, abandoned fields, burned-over areas, and roadsides. The list of the flora includes 1610 species and varieties. Common names are given when they are available, and under each species are given its principal habitats. Finally there are a glossary and a bibliography. The book is illustrated with excellent photographs showing types of vegetation, a map giving the general location of Oakland County, and two large maps carried in a pocket at the back. One of these larger maps shows the disposition of glacial deposits in the county, and the other is a land type map compiled by J. O. Veatch and N. L. Partridge of the Michigan State College of Agriculture. Needless to say, these maps add greatly to the general usefulness of the book.

The author has drawn up what appear to be logical relationships between plant communities and the land forms upon which they grow. She has applied the developmental concept rather cautiously for the most part, and has kept her discussions delightfully free of the terminological patter that so commonly obscures papers of this nature. I found myself wishing that she had made her basic correlations between land and vegetation a little more easily found, perhaps by means of a map or a summary. Such comments as I can make might be considered as suggestions for the extension of her project rather than as criticisms.

In her treatment of original vegetation she has used the usual historical method—delving into early narratives, old letters, promotion literature, etc. So far as the material has allowed, she has apparently done a good job; but perusal even of the included quotations will bring to light "loose ends" and reports that need verification. One wonders whether a method such as we have used here in New England, involving official records of land tenure, would be successful in a middle western locality like Oakland County.

A field left entirely untapped has to do with the influence of the inherent characteristics of the species themselves upon their presence and distribution in southeastern Michigan. Throughout the paper there is repetition of the idea that "the vegetational cover of any area is the result of the interaction of environmental factors: soil, drainage, topography, climate, and the presence of living things." It seems to me necessary to remember that before these external influences can be effective, there must be plants for them to react upon. The source and history of the species themselves, therefore, becomes a potentially important factor for rationalizing existing conditions, along with the external influences. The author has dismissed this problem by adhering to the traditional concept of a pre-Wisconsin flora of plants which "fled before the

ice and arctic temperatures to regions to the south, where they remained in a kind of natural conservatory until the final retreat of the glacier, thousands of years later." With the retreat of the glaciers, the plants are thought simply to have migrated back again from their southern refuge. In the light of investigations of our boreal and north temperate floras by Fernald, Hultén and others, however, it now seems impossible to rely upon this simple explanation. The glaciers apparently did more than cause the migration of species—they *destroyed* large elements of the populations, thus altering in many cases the capacities of the plants to migrate and readjust themselves. The structure of the flora and plant communities of Oakland County may well have been determined in part, therefore, by the behavior of the species involved, following the vicissitudes through which these species were forced by the last advance of the glaciers. Miss Bingham's excellent study of the flora and physiographic history of this region should make it an excellent area in which to carry on with investigations of the geographic origins of the flora.

HUGH M. RAUP

THE FLORA OF THE ISLAND OF ST. BARTHOLOMEW (FRENCH WEST INDIES) AND ITS ORIGIN.

By Adrien Questel. Imprimerie Catholique, Basse-Terre, Guadeloupe. $2.00 (paper). vii + 224 pp.; 3 maps. 1941.

The Island of St. Bartholomew, perhaps better known as "St. Barts," is in the French West Indies at lat. 17° 54′ N. and 62° 49′ W. It is a small island, about 6 miles long and at most 3 miles wide, with mountain peaks 800 and 1,000 feet high. The climate is dry and moderately warm. The present volume attempts to bring up to date (1941) and assemble in one place all available botanical knowledge of the island. The author, judging by his Foreword, is a native of the place, and has long been engaged in business enterprises in the West Indies. His botanical work, apparently begun as a hobby, has finally come to fruition in this scholarly treatise on the flora.

About 56 pages at the beginning of the book are devoted to an Introduction in which are brief outlines of the geographic setting of the island, its geology, exploratory history, the origin and evolution of its flora, and the local distribution of its vegetational elements. Of particular significance is the discussion of the geographic affinities of the flora. On geological grounds the author concludes that the island has not been connected by land with neighboring islands or with North or South America since it last emerged from the sea. He believes, therefore, that the present native flora is of waif origin. His studies of floristic affinities indicate clearly that the closest relationship is with the Greater Antilles, and that the plants "could only have been carried to the Lesser Antilles by the natural agencies of wind and sea currents." Present conditions, however, force him to the following hypothesis: "But, in the present days, these agencies [winds and currents] are distinctly unfavorable to such a migration. It must be then that, for a considerable lapse of time, probably during the glaciation periods of the Pleistocene, the winds and the sea currents had a different direction, West-East or North-West-South-East, favorable to a migration from the Greater Antilles."

Most of the author's collecting on St. Barts was done in 1937 and 1938. Duplicates of his specimens are deposited in the U. S. National Herbarium or at the New York Botanical Garden. The Catalogue enumerates 509 species, including cryptogams as well as higher plants. Of the phanerogams (486 spp.), 361 are regarded as wild, 57 are introduced useful species, and 68 are introduced ornamentals. Only 2 species and 2 varieties are noted as endemic.

In addition to the Introduction and the Catalogue, the book contains a bibliography of 35 titles, some notes on fruits and other useful plants of the island, and indices to families and genera as well as a general index. There are adequate maps and one half-tone plate.

HUGH M. RAUP

A CATALOG OF ILLINOIS ALGAE. *Northwestern University Studies in the Biological Sciences and Medicine, Number 2.*

By Max E. Britton. Northwestern University, Evanston. $3.00. viii + 177 pp. 1944.

A list of 178 genera and 962 species of algae "... known by the writer, from published or unpublished sources, to occur in the State." Also included is a brief review of the literature and a seven-page bibliography on Illinois algae.

TREES AND TOADSTOOLS.

By M. C. Rayner. Faber and Faber, London. 6 s. 71 pp. + 18 plates. 1945.

This fascinating little book is an excellent example of a successful attempt by a well-known scientist to give a popular account of her particular field of investigation.

In *Trees and Toadstools*, Rayner has given us an account, written in clear language understandable to the layman interested in science, of the symbiotic relationship which has been found to prevail between the mycelium of many of the higher fungi and forest trees. After answering in concise language the question "What are toadstools?" she gives a synoptic picture of the role of these and other fungi in the vast environment of the soil. She then turns to curious

and spectacular examples of fungus-flowering plant association, explaining in detail such a striking instance as that of the Honey Agaric (*Armillaria mellea*) with the orchid *Gastrodia*, where, it will be recalled, the fungus is necessary for flowering. The story of Frank's epochal discoveries, originally initiated as a project to increase the supply of truffles but resulting in the real opening of research on the important field of forest tree root and fungus association, is well told in simple language. A summary of later researches unquestionably linking up various familiar "trees and toadstools" in this curious nutritional relationship follows. Throughout, the reader is made keenly aware of the significance of mycorrhiza in the whole complex environment of the soil, as well as of their importance as a nutritive mechanism for both tree and toadstool.

M. C. Rayner's little book is certainly not the largest or most technical which has appeared recently, but it gives us in simple language, with the authority of one who really knows, a resumé of a curious field of plant biology that should prove of great interest to the layman, to the botanist, and in particular, to the forester.

F. K. SPARROW

A MANUAL OF THE ASPERGILLI.

By Charles Thom and Kenneth B. Raper. Williams & Wilkins Company, Baltimore. $7.00. ix + 373 pp.; 7 plates. 1945.

In these days of large-scale pioneering in such fields as tropical deterioration of war materials, obscure fungus diseases of man, antibiotic substances, etc., the publication of such a manual of the Aspergilli as the present one must, necessarily, be an important event. One needs only to consult the "Topical Bibliography," a highly useful and unique feature of this book, to discover, if he is not already aware of it, the importance of these fungi not only in those fields already mentioned but in such essential industrial processes as the manufacture of organic acids and enzymes.

The authors are well known to professional mycologists as recognized leaders in microbiological research and as specialists in the fungi with which this volume deals. Hence, the user of this manual may feel confident that he is getting the best possible guidance and critical judgment in the interpretation of species.

The book is clearly stated to be a manual and not a monograph. Its purposes are "(1) to provide the worker encountering an *Aspergillus* with means for its identification and hence to open to him the whole literature of the group, as well as the particular species; and (2) by enumerating all forms found in the literature, and indicating their proper allocation, to guide the user of that literature in the interpretation of names found in his reading but not known to him in nature, in culture, or in exsiccati."

Structurally, the book is divided into three principal parts, namely, "General Discussion," "The Manual Proper," and "Reference Material." In the 78 pages devoted to "General Discussion" are found such matters as the historical background of the Aspergilli, their position in the classification of the fungi (both in the Ascomycetes, for those with perfect stages, and in the Fungi Imperfecti, for obviously related fungi lacking an ascosporic stage), and a brief but concise discussion of generic diagnoses and synonymous genera. There then follows an important chapter on "Morphology and Description" in which are described in detail, with the aid of line drawings, half-tones, and even color photographs, the cultural, morphological, and developmental features of use in the determination of species. The care in exposition which has gone into the preparation of this chapter and the succeeding ones on "Cultivation and Examination" and "Preservation of Cultures" will make the book especially valuable to novices in the general field of the fungi and in the handling of cultures, as well as to mycologists unfamiliar with this particular group of organisms.

Following a final chapter in Part I on "Variation," which consists of an illustrated discussion of these variable and mutable fungi, the reader proceeds to Part II, "The Manual Proper." In the succeeding 207 pages are presented concise information on how to use the manual, keys to the groups, and the authors' interpretation of the 89 species, varieties, and mutants recognized by them. Three different keys are given the would-be identifier of an *Aspergillus*, enabling him to place his fungus in its proper group. The first is a diagrammatic, natural one, based primarily on morphological characters. The second is based primarily upon color, and is wholly artificial; whereas the third is of the more orthodox dichotomous type, utilizing morphology and color as well.

Although the treatment of the various groups differs somewhat in structure, it usually starts with a brief list of outstanding characters, followed by a key to the species. For each species the citation of the original description and significant synonyms are given. There then follows a technical description of the species, based for the most part on living cultures known to the authors. In this connection they state: "For the purposes of this manual, an attempt has been made to base the use of the individual name upon the morphological picture most frequently encountered, rather than upon a selected strain assumed to be, but not known to be, the one first described." After each species description are cited one or more cultures in the collection of the Northern Regional Research Laboratory which best typify it. Following this, there is an informative discussion of various fungi referred in the past to the particular species, an evaluation of these, a consideration of possible synonyms, etc.

Each chapter on a group closes with a discussion of the special features possessed by its members, such as

acid- or enzyme-producing properties, occurrence, pathogenicity, and formation of antibiotic substances. These special features are also summarized in the "Topical Bibliography" previously mentioned.

Part III, "Reference Material," consists of the Topical Bibliography of 29 pages, a General Bibliography of 11 pages, a complete check-list of species and genera, and a list of accepted species, varieties, and mutants.

It is, of course, difficult for one not a specialist in this very intricate and notoriously complex group of fungi, replete with so many special problems of physiology and taxonomy, to evaluate critically Thom and Raper's treatment of the Aspergilli. It is easy to discern, however, that they have given their material careful and exhaustive study, have fair-mindedly and with considered judgment evaluated the work of others and have striven to produce a working tool for the identification of species of an important group of fungi. One cannot help wishing, however, that more care had gone into the editing of the manuscript and general book-making. It is difficult to understand, for example, why Figure 7, taken from de Bary, was not trimmed of its superfluous blank margins and made to conform to the normal page width. Throughout, there are instances of careless editing, especially noticeable, for example, in the variations in methods of abbreviation and citation of periodicals. A few of these may be given: "Centralb." and "Central."; "Bul. Soc. Mycol. France", "Soc. Mycol. France Bul.", "Bul. Soc. Myc. France"; "Ann. Sci. Nat. Ser. 9, II," "Ann. Sci. Nat. Bot. IX, 2"; "Ann. Mycol. 27:"; "Ann. Mycol. 28 (3/4)"; etc. These and the erratic use of accent marks are hardly serious obstacles to the determination of a species of *Aspergillus*, but they are detractions from an otherwise fine book which it is to be hoped will be eradicated in a future edition.

One cannot but admire the courage and skill of the authors in wading into so complex a group and in succeeding in producing so lucid and simple a manual.

F. K. SPARROW

HEPATICAE OF NORTH AMERICA, *Part III. University of Washington Publications in Biology, Volume 6, Number 3.*

By T. C. Frye and Lois Clark. University of Washington Press, Seattle. $3.00 (paper). iii + pp. 337–564; 1 table. 1945.

This is a continuation of a monographic treatment, the earlier parts of which were published in 1937 and 1943. It covers six families of the liverworts: Lophozioideae, Plagiochiloideae, Harpanthoideae, Odontoschismoideae, Cephalozioideae, and Cephaloziellioideae. The book is well illustrated with line drawings, and has ample keys to genera and species. Detailed descriptions are given for each species, with references to published illustrations, citations of specimens, geographic ranges, and critical taxonomic discussions. I find only one new variety described, *Cephaloziella papillosa* var. *sinuata*; but there are three new nomenclatorial combinations: *Leiocolea ruthamea, Temnoma setiforme* var. *alpinum, Cephaloziella papillosa* var. *heterophylla*. At the end there is an index to the three published parts (pp. 7–560).

HUGH M. RAUP

HAYFEVER PLANTS. *Their Appearance, Distribution, Time of Flowering, and their Role in Hayfever, with special Reference to North America. A New Series of Plant Science Books: Volume XV.*

By Roger P. Wodehouse. The Chronica Botanica Company, Waltham, Mass.; G. E. Stechert and Company, New York. $4.75. xix + 245 pp. 1945.

Here is a book which should be in the reference library of every physician who is engaged in the study and treatment of hayfever. The allergist is often sadly lacking in the basic knowledge of pollens which cause hayfever and the plants which produce them, not only because he has been engrossed in the clinical problems of pollenosis but also because of the difficulties he has encountered in delving for information in botany, a field entirely strange and difficult for him. A great service has been rendered therefore by Roger P. Wodehouse, a trained botanist, familiar with the clinical problems of the allergist when he provides a comprehensive and authoritative botany of hayfever.

The author's book is divided into two parts. In the first there is an important chapter upon pollens and pollination. Pollen formation and pollen distribution are described, with a discussion of the characteristics which must be present in order for a pollen to be able to produce hayfever. The significance of estimating the atmospheric pollen is explained. The various methods of determining the daily amount of pollen present in the atmosphere are described.

The greater portion of the first part of the book, however, is devoted to the hayfever-producing plants and their pollens as they are found in North America, particularly throughout the United States. In language as non-technical as possible, the author describes the features of the plants and their pollens. He lists the sections of the country in which the plants are found and the seasons of the year in which the pollens mature. The importance of the various pollens in causing hayfever is given.

The knowledge which the clinical allergist possesses of hay-fever-producing plants and their periods of pollination may often be precise for the area of the United States in which he practises but quite vague for other parts of the country. The second half of this book will do much to dispel this vagueness, as it

is devoted to the findings of many regional pollen surveys which have been conducted throughout North America. For each of the ten areas into which the author has divided the United States, there is given a description of the pertinent plants. For each area there has been provided a table which furnishes concisely the names of the plants of general importance, and of those of special importance together with their periods of pollination.

In this volume the many illustrations of pollens and plants are the work of the author, and they reveal that he is an artist as well. They are the products of a draftsman who has a full appreciation of the beauty and of the gracefulness of the plant material with which he works. One feels that the production of this attractive book must have been a joy and a satisfaction to him and to his publishers.

W. C. SPAIN

ANGIOSPERMAE: REIHE GLUMIFLORAE. GRAMINEAE III (UNTERFAMILIE PANICOIDEAE). *Die natürlichen Pflanzenfamilien nebst ihren Gattungen und wichtigeren Arten, insbesondere den Nutzpflanzen. (Engler and Brantl). Volume 14 e.*

By R. Pilger. (Wilhelm Engelmann, Leipzig); J. W. Edwards, Ann Arbor, Michigan. $5.50. 208 pp. (1940); 1945.

As indicated in the title, this book covers the tribes of grasses contained in the subfamily Panicoideae. These tribes are the Paniceae, Arthropogoneae, Andropogoneae, and Maydeae. Keys and descriptions to the genera for the entire world are given, with 106 text figures in the form of line drawings. Following the main systematic treatment, there is a brief discussion of the taxonomic organization of the subfamily, and finally an index to names. The book as we have it is a lithoprint of the original, which was published in Leipzig in 1940. So few copies of the latter reached America before the United States entered the war, and demand for the volume here was so great, that this reproduction was made and the book has now become generally available.

HUGH M. RAUP

UNIVERSITY OF COLORADO STUDIES *Series D. Physical and Biological Sciences. Vol. 2, No. 2.*

Contents: A Synopsis of the North American Species of Delphinium, by Joseph Ewan; Hydrography and Morphometry of Some Northern Colorado Lakes, by Robert W. Pennak; Some Aspects of the Regional Limnology of Northern Colorado, by Robert W. Pennak. University of Colorado, Boulder. $1.00 (paper). Pp. 55–294. 1945.

PLANT PHYSIOLOGY

PLANT FACTORIES. *The Basic Science Education Series.*

By Bertha Morris Parker and Orlin D. Frank. Row, Peterson and Company, Evanston, Illinois. 32 cents (paper); 24 cents on orders of 5 or more. 36 pp. 1944.

This booklet, written for the fifth grade child, is a first-rate accomplishment. It first makes clear the dependence of all animal life upon plants, then takes up sugar and starch synthesis, and leaf and stem anatomy as related to the synthetic processes. Stomata and root hairs are thus related to the activity of photosynthesis. Protein synthesis and its relation to the nitrogen cycle; vitamins; storage organs; fruits and seeds; and drug products, spices, etc., obtained from plants are other topics. There is a concise summary, and an excellent list of suggested experiments and observations for the child to carry out. The booklet is very attractively illustrated in color and black and white.

BENTLEY GLASS

RESPIRATION AND GERMINATION STUDIES OF SEEDS IN MOIST STORAGE. *Annals of the New York Academy of Sciences, Volume 46, Art. 4.*

By Lela V. Barton. New York Academy of Sciences, New York. 50 cents (paper). Pp. 185–208; 3 plates. 1945.

This paper deals with the metabolic activities of imbibed seeds of *Amaranthus retroflexus, Impatiens balsamina,* and *Rumex obtusifolius,* stored for an extended period at a constant temperature of 20° C. That imbibed dormant seeds of these species exhibit reduced respiratory rates soon after the water is absorbed is demonstrated. A ten-fold reduction in respiration of *A. retroflexus* seeds occurred by the end of the first year of moist storage. The mechanism involved was not determined. A respiratory quotient of approximately 0.7 was observed in early stages of the tests. This suggested that lipins were consumed before carbohydrates were respired. Anomalous germination was observed in seeds of *A. retroflexus* and some of the possible causes suggested offer approaches for further study. The paper is of special interest to plant physiologists and seed analysts.

C. G. SCHMITT

PLANT GROWTH.

By L. Edwin Yocum. The Jaques Cattell Press, Lancaster, Pennsylvania. $3.00. 203 pp.; 16 plates. 1945.

Created especially for the layman gardener, as a non-technical guide to the mysteries of plant growth and

the fundamental laws of nature governing growth processes, Yocum's book also provides interesting and profitable reading alike for the professional botanist and the enthusiast in plant culture techniques.

In addition to such elemental topics as Seeds and Seedlings, Germination, Morphology of Roots, Stems and Buds, Mechanics of Water Absorption, and Mineral Nutrients, the author devotes several brief but well balanced chapters to Essentials for Food-making in Plants, Transpiration, Balance of Root and Shoot, Insects and Diseases, Weeds, Hybridizing Plants, Plant Hormones and Their Commercial Uses, and Soil Improvement. The book not only provides information on "what to do in caring for plants—but also gives adequate reason for each step." A valuable but not too extensive reference list concludes each chapter, and for the further enlightenment of the layman, a glossary of essential technical terms is appended.

LADEMA M. LANGDON

PROBLEMS IN TREE NUTRITION. *An Account of Researches Concerned Primarily with the Mycorrhizal Habit in Relation to Forestry and with some Biological Aspects of Soil Fertility.*

By M. C. Rayner and W. Neilson-Jones. Faber and Faber, Ltd., London. 12s. 6d. 184 pp.; 27 plates. 1944.

This treatment of the subject of mycorrhizas in relation to tree growth presents convincing evidence of the beneficial action and specificity of mycorrhizas on conifers. The researches upon which this book is based were pursued in a methodical manner for more than ten years. The logical methods employed in converting an infertile soil that would not support tree growth into a soil conducive to active growth of forest trees resulted in uncovering ecological and soil fertility relationships of special interest to botanists, foresters, and soil scientists everywhere. A new technique for biological analysis, the nutrient-agar-film method, is described. This easy method for determining the relative degree of soil toxicity may find wide application in the diagnosis of soil disorders.

C. G. SCHMITT

ECONOMIC BOTANY

NEW CROPS FOR THE NEW WORLD.

Edited by Charles Morrow Wilson. The Macmillan Company, New York. $3.50. viii + 295 pp.; 32 plates. 1945.

As more and more of our vital raw materials were cut off during the war (90 per cent of our essential tropical commodities were imported from the Eastern Hemisphere), the question was repeatedly asked: "What are we going to do about it?" This book is an answer to the question. The editor, Charles Morrow Wilson, although an authority on Middle America in his own right, has not been content merely to put down his own ideas, but rather has chosen to have fourteen distinguished specialists in tropical agriculture present their own views and outline the recent developments and future possibilities in their several fields.

The editor is himself responsible for the introduction, in which he presents and supports the thesis that America needs more and better crops with the goal of making possible, for reasons of hemisphere security, the inter-American production of a reasonable proportion of the various crop materials that are essential to Pan-American survival in war and that are validly beneficial to Pan-American agriculture in peace.

Wilson Popenoe is the author of two articles. In "The Undeveloped Field of Tropical Fruits," he discusses the attractive future possibilities of the mango, lychee, kaki, cherimoya, mangosteen, guava, papaya, and other interesting fruits. In "Cinchona the Fever Tree," he treats of the recent attempts which have been made to establish a quinine industry in the Western Hemisphere and discusses the outlook for the future. Edgar Anderson traces the history of "Maize in the New World," an old American crop which, due to modern science, is now "impressively and decisively new." Albert O. Rhoad, in "The Fashioning of Livestock Breeds," tells of the current progress in animal husbandry, particularly the breeding of livestock to meet the changing domestic and environmental needs of the Americas. In "Palm Oils and Waxes," Miriam L. Bomhard points out the great economic importance of the oils and waxes derived from palms and describes many of their industrial uses. In what the editor considers the "most authentic and informative article on rubber" yet to appear, "Rubber Returns to Latin America," Walter N. Bangham presents the history of the attempts to reestablish the *Hevea* rubber industry in the American tropics. He concludes that with proper care and attention *Hevea* trees are capable of developing even better in Latin America than in the former rubber-producing centers, and that they should prove a valuable type of culture for small land owners along with their food crops.

E. C. Higbee and Atherton Lee, in "Drug and Medicinal Crops," call attention to several outstanding new drug plants and their culture, and also to several old ones which are increasing in importance. C. P. Clausen describes the progress made in the "Biological Control of Insect Pests" by utilizing natural enemies of the destructive insects which ravage our tropical crops. Arthur Bevan summarizes the stupendous "Forest Resources of Tropical America" and pleads for the conservation rather than the exploitation of these resources. In "Silks from South America," George E.

Adames tells of the new Brazilian silk industry located chiefly in São Paulo. Its future success depends on greater productivity and yield, problems which the efficient Service of Sericulture of the Brazilian Government is investigating. Atherton Lee, in "Bamboos in the New World," paints a possibly too optimistic picture of the future role of the bamboo in tropical America. The author feels that the use of disease-resistant species will make possible the industrial utilization of bamboos to such an extent that they may become the most important crop in the American tropics. A. T. Erwin describes new uses and developments for one of America's most ancient crops. In "Peppers for the Americas," he shows that this universally used article fulfills a dietary need for which there is no substitute.

B. Y. Morrison contributes two articles. In "Flowers for the New World," he tells of many of the horticultural species which have come to our greenhouses and gardens from Latin America. In "American Plants for the Americas," he discusses the problems involved in transplanting native crops from one part of the hemisphere to another and points out that it is often easier to transplant species to much more distant parts of the world where, however, climatic conditions are more nearly the same. Because of the limiting factors of soil, climate, and economics the author recommends that tropical plants be restricted to truly tropical countries. He also shows that the indifference of the public makes it difficult to launch a new crop, as evidenced by the dasheen and chayote.

In "Cane Sugar Production," P. Honig summarizes the world sugar industry chiefly from the standpoint of production. Advances in recent years are due to the centralization of the processing factories and to increases in production made possible by improved cultural methods and the selection of high-producing varieties through cross breeding. The author looks for more and cheaper sugar in the future.

While the preceding contributors have written in a more or less general or theoretical manner, the final article deals with the purely practical. "Launching New Crops for the Americas" was not written for publication but comprises excerpts from work reports of V. C. Dunlap and his associates dealing with the actual cultivation of many strategic crops. Its inclusion in this volume was "solely the editor's idea" and a most happy one. Here is presented the story of actual achievements in growing abacá, essential oil plants, the African oil palm, teak, bamboo, castor beans, roselle, luffa sponges, and many other tropical species.

All in all, the book is a very readable and at times stimulating account of the present status and future possibilities of tropical crops in the New World, and has the added advantage of being scientifically accurate.

ALBERT F. HILL

GRAPES. (*Easy Science Series*).

By Workers of the War Services Project of the Work Projects Administration in the Commonwealth of Pennsylvania. Albert Whitman and Company, Chicago. 50 cents. 46 pp. 1945.

This is an interesting and well-written booklet for children in the third and fourth grades or older. It is attractively illustrated, and discusses the kinds of grapes; the history of grape-growing; vineyard planting; growing from cuttings, layering, and grafting; the enemies of grapes, especially the Phylloxera; feeding the vines; gathering the crop; raisins, grape juice, and wine; and odd and interesting minor uses. It is highly recommended.

WEEDS OF LAWN AND GARDEN. *A Handbook for Eastern Temperate North America.*

By John M. Fogg, Jr. University of Pennsylvania Press, Philadelphia. $2.50. vii + 215 pp. 1945.

Fogg has presented, in *Weeds of Lawn and Garden*, an exceedingly useful and informative little book. It is of handy size, well-organized, and well illustrated with line drawings. To the growing number of gardeners, both amateur and professional, it should be on the required list—an aid to the solution of the ever-present weed problem.

The first twenty-four pages of the book are devoted to an introduction in which the author discusses, in comprehensive though condensed form, some of the background and problems of weed study and eradication. The following headings will indicate the content: What Is a Weed, Why Some Plants Are Weeds, The Dispersal of Weeds, The Geographic Origin of Weeds, The Extermination of Weeds, Chemical Controls, Weeds as Soil Indicators.

The main part of the work contains descriptions of the plants which commonly appear as native or introduced weeds in our lawns and gardens. The species are arranged in "systematic" order, according to the Engler and Prantl scheme, essentially that of Gray's Manual and most other botanical manuals of our country. Geographically the book covers "eastern temperate North America." The principal species are illustrated by excellent drawings. Both common and scientific names are given for each, along with its geographic origin and duration of life (annual, perennial, etc.). For each species also there are brief descriptions of habitat, structural characteristics, methods of control, with mention of closely related species or varieties. The book closes with a brief but effective glossary, a selected bibliography, and an index.

HUGH M. RAUP

CINCHONA IN JAVA. *The Story of Quinine.*

By Norman Taylor. Introduction by Pieter Honig. Greenberg, New York. $2.50. 87 pp.; 16 plates. 1945.

This little volume presents the fascinating story of quinine in a clear and concise manner. An introduction by Pieter Honig, a Dutch scientist with years of experience in the tropics, summarizes the history of East Indian agriculture and points out the wise agrarian policies of the Dutch Government which made possible the plantations of export crops.

The first two chapters present the general background of cinchona and its use. The history of malaria, the use of cinchona in its treatment, the nature and life history of the malarial organism, the nature of the disease and its control measures are among the topics discussed.

The next two chapters deal with cinchona itself: the discovery of the bark, its exploitation in South America, its increasing importance as a drug, and the early attempts of the British and Dutch to transfer *Cinchona* from the New World to the Old, especially the efforts of Markham and Hasskarl. These attempts failed because the species used, chiefly *Cinchona calisaya*, were too low in quinine content to be profitable. The English continued to use disadvantageous species and unprofitable methods; the Dutch, however, were more open-minded and soon Java was on the road to becoming the world source of quinine.

The final two chapters are devoted to the development of the cinchona industry in Java. Initial success was due to the introduction of *Cinchona Ledgeriana*, which has a high yield of quinine sulphate. The problems involved in the establishment of this species are discussed in detail. Final success may be attributed to the fact that the Dutch Government carried out extensive preliminary experimental work on quinine production and only turned the business over to private hands when they had clearly demonstrated what was necessary to make cinchona culture successful. Perhaps no other tree has had more patient and intelligent care bestowed upon it. The characteristics of the tree and its culture requirements are fully treated under such heads as soil, choice of site, seed beds, care of seedlings, methods of grafting, and cultivation. The harvesting and processing of the bark is also described.

Two species of *Cinchona* are now grown in Java and between them the Dutch were able to supply all the cinchona alkaloids. *C. Ledgeriana*, extraordinarily high in quinine production, but low in quinidine, cinchonine, and cinchonidine, is the source of the "Factory Bark" used for making quinine sulphate. *C. succirubra*, with a very low quinine content, but high in the other alkaloids, is the source of the "Pharmaceutical Bark" used in making totaquina and other pharmaceutical preparations. The robust *C. succirubra* is also used as the stock on to which the less resistant *C. Ledgeriana* is grafted.

The book concludes with a brief reference to the underlying economic conditions and the future outlook for the world quinine industry. Perhaps the only real criticism of the work is its failure to comment more fully on the nature and possibilities of the extensive experimental work with cinchona carried on in Central and South America during the past few years.

ALBERT F. HILL

ETHNOBOTANY OF WESTERN WASHINGTON. *University of Washington Publications in Anthropology, Volume 10, Number 1.*

By Erna Gunther. University of Washington Press, Seattle. $1.50 (paper). 61 pp. 1945.

A survey of the plant uses of the Indian tribes of Western Washington has been made by the author. Plants were collected in the field, whenever possible with one of the Indian informants. Identifications of the plants were established by botanists, and the native names and uses of the plants were carefully recorded. The plants are arranged and described under their botanical classification. The usages are generally: food, technical, and medicinal. There is a table giving the presence and absence of use for each plant for each tribe, an index, and a bibliography. Such detailed factual works as these are useful bricks added to the scientific structure.

GEORGE F. CARTER

GENERAL AND SYSTEMATIC ZOOLOGY

THE FULGOROIDEA, OR LANTERNFLIES, OF TRINIDAD AND ADJACENT PARTS OF SOUTH AMERICA. *Proceedings of the United States National Museum, Vol. 95. No. 3184.*

By R. G. Fennah. Smithsonian Institution, United States National Museum, Washington, D. C. Pp. 411–520; 11 plates. 1945.

The title indicates the scope of the work. The included genera and species are fully described with many interesting illustrations. A considerable number of new genera and species are dealt with in detail. A brief account of the relations of the species occurring in Trinidad with those on the continent is presented. This work is of primary interest to the taxonomist.

A MONOGRAPH OF THE BEETLES ASSOCIATED WITH STORED PRODUCTS. *Volume 1.*

By H. E. Hinton. The British Museum, London. £1 10s. viii + 443 pp. 1945.

Here is a work the reviewer has long desired, and at last it has appeared in even more detailed form than was anticipated. As stated in the preface, it is the

result of requests made to the Department of Entomology of the British Museum by the Department of Scientific and Industrial Research for more accurate and detailed information on insect pests of stored products. Though the work is restricted to the beetles, and unfortunately only one-third of those (although the most important) are treated here, yet the work has been done so thoroughly and in such an excellent manner that it should form the basis for future studies upon groups of insects that are of importance to man's economy. Fortunately, the author has omitted all reference to control measures, as so many of those recommended are ephemeral and new and better ones are constantly being developed.

As the beetles associated with stored products are not only small but very small, the author has rightly concentrated in presenting in readable form detailed accounts of each insect, most of them with admirable illustrations of all stages. The author states "that much confusion reigns in the literature on stored product beetles, and that the few works that profess to facilitate identification sometimes achieve the opposite result." This can be easily understood when it is recognized that about 600 species, distributed among 34 families, have been found associated with stored products. Of these, 175 are described in detail, with admirable keys and illustrations. These belong to the families Carabidae, Staphylinidae, Nitiulidae, Lathridiidae, Mycetophagidae, Colydiidae, Murmidiidae, Endomychidae, Erotylidae, Anthicidae, Cryptophagidae, and Dermestidae. Another 25 species are included in the keys but are not described in detail.

The reviewer has found the keys not only accurate but admirably illustrated, so that entomologists should be able to identify these pests with more certainty than heretofore. Furthermore, the detailed accounts of the biology of each species should prove very valuable. The treatise concludes with an extensive bibliography of 27 pages. This work should prove of great value to all those interested in stored products.

ROBERT MATHESON

FURTHER STUDIES IN PSELAPHIDAE (COLEOPTERA) OF MEXICO AND GUATEMALA. *Bulletin of the Chicago Academy of Sciences, Vol. 7, No. 7.*

By Orlando Park. Chicago Academy of Sciences, Chicago. Pp. 331–443. 1945.

This is a continuation of the author's work on this interesting family of beetles. Here he describes two new genera, one new subgenus, twenty-six new species, three new subspecies, and two new varieties. Keys are given to most of the species known to occur in Guatemala and Mexico. Notes are also presented on their geographical distribution.

CHECKLIST OF THE COLEOPTEROUS INSECTS OF MEXICO, CENTRAL AMERICA, THE WEST INDIES, AND SOUTH AMERICA. *Part 3. United States National Museum, Bulletin 185.*

Compiled by Richard E. Blackwelder. United States Government Printing Office, Washington. 45 cents. Pp. 343–550. 1945.

This is a continuation of the list begun in 1944. For information regarding the arrangement and meaning of the list, workers should consult Part 1.

THE NEOTROPICAL GENUS SYNTERMES (ISOPTERA: TERMITIDAE). *Bulletin of the American Museum of Natural History, Volume 83, Article 7.*

By Alfred E. Emerson. American Museum of Natural History, New York. 50 cents (paper). Pp. 427–472. 1945.

This is a detailed account of the taxonomy and ecology of the genus *Syntermes*, which is confined to South America. The author presents a detailed map showing the known distribution of the species in South America. Elaborate accounts of each species are given with illustrations.

SPORT FISHING IN HAWAII.

By Edward Y. Hosaka. Bond's, Honolulu. $2.75. 198 pp. 1944.

Those interested in fishing will certainly appreciate the wealth of information presented in this combination guide, manual, and handbook. This book will be of most advantage in the territorial waters of Hawaii, but the information ought to be equally applicable to fishing for closely related kinds of fishes in other areas of the Pacific.

The first part of the book presents methods of fishing, including casting, whipping, poling, torch fishing, trapping, netting, as well as a consideration of when and where to catch the fish. The equipment to be used, including bait, hooks, lures, leaders, swivels, sinkers, etc., is described and illustrated by pen and ink sketches. Wisely, in certain debatable cases, the writer does not commit himself on any particular choice of equipment, but allows experience and personal idiosyncrasies to make the final decisions. The uninitiated may shudder at some of the dialect, as "shrimp is good for catching *papio*, *moano*, *aholehole*, and many other small fish, *pao'o* and *dojo* are good for *papio*, the *aama* crab is excellent bait for *moi* . . .," but the terms are translated sooner or later. Recipes for cooking the edible fish complete Part One.

The second part of the book provides a synoptic artificial key to the fish. Each species is illustrated, and all the necessary information for its capture is included. A glossary and the fishing laws of Hawaii are appended.

HENRI C. SEIBERT

TURTLES.

By Wilfrid S. Bronson. Harcourt, Brace and Company, New York. $1.75. 60 pp. 1945.

The general anatomy, varied adaptations, habits, and life histories of the chief kinds of turtles—related and illustrated with humor and adroit skill, for very young biologists. This is one of the best recent nature books for youngsters. It is sure to appeal to anyone under the age of ten.

A PRELIMINARY ANALYSIS OF THE HERPETOFAUNA OF SONORA. *Bulletin of the American Museum of Natural History, Volume 83, Article 6.*

By Charles M. Bogert and James A. Oliver. American Museum of Natural History, New York. $1.50 (paper). Pp. 297–426; plates 30–37. 1945.

A considerable proportion of the active herpetologists of this country have been studying the amphibians and reptiles of Mexico. The result has been a volume of diverse contributions, with major emphasis on taxonomic studies and regional lists, as is to be expected from the present state of our knowledge of Mexican herpetology. The present paper uses these studies as a point of departure and offers a rather intensive review of the frogs, toads, lizards, snakes, and turtles (no Caudata nor Crocodilia are known from the area) that have been found in Sonora.

Sonora is a northwestern state of Mexico, with the major part of its northern border shared with Arizona. From this area Bogert and Oliver report 125 forms of amphibians and reptiles and anticipate that further collecting and study will bring the total up to 180. Following a general account of the topography and geography of the collecting stations, there are interesting discussions of the faunal relationships of past distributions (deduced from the present distributions) and the present distributions. Three elements of the herpetological fauna are recognized, the Holarctic, Old Northern, and South American. It is suggested that the Old Northern, with 45 genera in thirteen families, antedated the South American (16 genera in 10 families) and Holarctic (1 genus) in the state. A short account refers to the time of entry of these faunal elements into the area, and a more detailed discussion outlines the dispersal routes for the many species. Five routes are described and diagrammed on an outline map. It is concluded that the origins of the present herpetofauna of Sonora involve: "(1) Pleistocene climatic changes; (2) southward withdrawals of populations on the peninsula of Baja California and on the mainland as a result of the most recent glacial period; (3) partial or complete differentiation during isolation; and (4) subsequent migrations or secondary dispersals by way of five main dispersal routes."

There follow two short chapters, one on the effectiveness of deserts as barriers and the other on biotic regions in Sonora, and the Annotated List of forms, which occupies about half the paper. Besides full descriptive details and some excellent illustrations, the List makes mention of some matters of general systematic interest, matters that deserve the broader audience they would have reached had they been distributed among several independent essays in journals with a different circulation. Buried in the text as they are, they will be noticed here by few others than specialists in Mexican herpetological systematics. Mention is made of the validity of estimating whether a dichotomous taxonomic character indicates a single gene difference or two interbreeding populations (p. 359); of clines and their systematic interpretation (p. 361 *et al.*); of the question of the importance of single characters at the generic level (p. 365); and of the place of monotypic genera in modern systematics (p. 374).

There are a few pages concerned with material not available at the American Museum of Natural History and a chapter evaluating the probability of occurrence in Sonora of an additional forty forms.

This is one of the first papers utilizing the new two-column, large-sized format of the *Bulletin*. The attractiveness of the paper is further enhanced by a half-dozen plates, including a few of the finest snake drawings to be found in any journal.

A few minor errors and defects have found their way into the publication. The Table of Contents lists the Amphibia, Reptilia, and Testudinata as equivalent groups. The term "mutant" is used in its general sense, whereas it would have been preferable to find a substitute word, since the term does have a restricted biological meaning. The word "ventrals" is substituted for "caudals" on p. 357. Some space could have been better utilized by reducing a few of the tables, as, for example, the nearly full page table (p. 340) which listed the stomach contents of a half-dozen toads. Postglacial dispersion is mentioned often, yet there is lacking a convincing statement concerning the importance of the glaciers in affecting the present distribution of semi-tropical amphibians and reptiles.

Without question this paper is a major contribution to our previously meager knowledge of Sonoran reptiles and amphibians. In addition several unsolved problems are clearly defined and the best methods of attack are sometimes indicated. These do not constitute its greatest potential value, however, and in this view I hope I have the concurrence of other herpetologists. Of more importance is the fact mentioned above, that the paper contains items of interest to biologists in general, and certainly to students of phylogeny and systematics. Such a trend in systematic writings is noticeable and deserves much encouragement.

ARNOLD B. GROBMAN

AN ANNOTATED CHECKLIST AND KEY TO THE SNAKES OF MEXICO. *Smithsonian Institution, United States National Museum Bulletin 187.*

By Hobart M. Smith and Edward H. Taylor. United States Government Printing Office, Washington. 50 cents (paper). iv + 239 pp. 1945.

Many herpetologists have waited anxiously for Smith and Taylor's Checklist of Mexican Snakes and few will be disappointed. This volume has been at once carefully and boldly executed. An enormous amount of material, much of which was collected by the authors, has been examined and a critical search of the literature has been made. More types of information are included in this list than in the *Checklist of United States Amphibians and Reptiles*, despite the fact that the major part of the information on the nearly 500 species of Mexican snakes has accumulated only during the last dozen years.

Following a short introduction, containing sections on nomenclature and zoogeography, there is a key to the genera of Mexican snakes. The families of snakes are next treated in systematic order. Within each family, or subfamily, the genera are arranged in alphabetical order. For all the polytypic genera there are keys to the species and subspecies. In each genus, the species and their races are considered in alphabetical order.

For each form the following information is included: synonymy (a reference to the original description of the name used, references to original descriptions of all synonyms having type localities in Mexico, citations of recent works, and reference to an illustration); type (the museum and number wherever possible); type locality; range (actual localities when localized, states from which known when wide ranging). For each genus there is given the following: synonymy (recent synoptic treatments and references to all names with Mexican species as genotype); genotype; range; species (the total number of forms in the genus and the number inhabiting Mexico).

After the main body of the report there are lists of all the forms definitely reported from each state. A few pages are devoted to those forms questionably considered to be Mexican and 22 pages to a specific index.

This monograph is a real achievement. Smith and Taylor have the broadest and most detailed knowledge of Mexican snakes that has yet been gained by field collecting, laboratory study, and review of the literature. Herpetologists and others will indeed be grateful that they have synthesized their present information and made it available in such a useful and compact form.

ARNOLD B. GROBMAN

THE SKETCH BOOK OF DOGS.

By Felice Worden. Bernard Ackerman, New York. $2.00. v + 116 drawings with text. 1945.

To each of the 116 recognized breeds of dogs the artist-author gives a separate page, headed by a drawing and followed by brief, often humorous notes. The sketches are characteristic in pose and conformation; commonly in profile only. They are not in color, and the technique does not always convey the quality and length of coat. Relative size is ignored, all the types being drawn of nearly the same dimensions. The notes are too brief to be really informative. For some breeds the heights are given, for some the weights, but only rarely both. Colors are usually given, but not always.

This book is not one to provide more than a superficial acquaintance with the breeds of dogs. As far as it goes, it is satisfactory.

BENTLEY GLASS

EXTINCT AND VANISHING MAMMALS OF THE OLD WORLD. *Special Publication No. 12.*

By Francis Harper. Illustrations by Earle L. Poole. American Committee for International Wild Life Protection, New York. $5.00 (cloth); $4.00 (paper). xv + 850 pp.; 1 plate. 1945.

In order to protect and preserve successfully the wild animals of the earth it is necessary first of all to compile our present knowledge concerning the vanishing forms of life and the factors responsible for the more or less rapid disappearance of so many species. The volume under review deals with those mammals of the Old World which have become extinct during the Christian Era and those which now are or may be threatened with the same fate. Through correspondence and, particularly, through an exhaustive use of the literature, the author has collected a great mass of information on the former and present ranges and numbers of vanishing mammalian species, on the dates and rates of disappearance of such animals as have already become extinct, either locally or completely, and, as far as can be known, on the direct and indirect causes of depletion.

During the past 2,000 years the world has irretrievably lost 106 known forms of mammals, two-thirds of which have become extinct during the last 100 years and more than one third since 1900. Europe has lost only 6 forms, whereas Australia has lost 11 and North America 27. Among the large predatory mammals, the Ursidae, Felidae, and Canidae have lost a total of 26 species or subspecies. In addition to the mammals already extinct, more than 600 others are regarded as vanishing or at least as threatened forms, deserving special protection.

There can be no doubt that the rapid rise of the human population and the spread of civilization are

the outstanding factors in the depletion of the mammalian fauna. Man's constantly progressing invasion and destruction of natural habitats and his manifold interference with the balance of nature (e.g., by introducing such foreign mammals as mongoose, rat, and rabbit in new localities) have decimated mammalian populations at least as effectively as hunting and poisoning. The author concludes that "comparatively few species seem to have died out within the past 2,000 years from natural causes, such as evolutionary senility, disease, or climatic change." It seems, however, that we know as yet far too little of the diseases in wild animals to declare disease a negligible factor in the disappearance of mammals.

The bulk of this scholarly volume is arranged taxonomically and gives accounts for each species, extinct, vanishing, or threatened, in regard to its past and present distribution and prevalence. Brief descriptions of the main species characters are included, and 70 forms are shown also in clear illustrations, prepared by Earle L. Poole. That the various mammalian orders differ very widely in the danger of extinction among their species is indicated by the following figures, giving the numbers of pages required for each order: marsupials 96, insectivores 1, primates 57, edentates 8, rodents 21, carnivores 88, proboscideans 6, odd-toed ungulates 91, even-toed ungulates 317, bats 1.

Specially noteworthy is the valuable bibliography filling 77 pages.

A. H. SCHULTZ

ECONOMIC ZOOLOGY

ANIMAL COLONY MAINTENANCE. *Annals of the New York Academy of Sciences, Vol. XLVI, Art. 1.* *By Edmond J. Farris, F. G. Carnochan, C. N. W. Cumming, Sidney Farber, Carl G. Hartman, Frederick B. Hutt, J. K. Loosli, Clarence A. Mills, Herbert L. Ratcliffe. New York Academy of Sciences, New York.* $1.50 (paper). 126 pp. 1945.

The inherent value of biological investigations is in no small part determined by the quality of the experimental animals. In order to set up a truly controlled experiment, the animals used must have not only the same genetic background, but the same physiological background up to the time the experiment is started. The problems associated with the successful maintenance of animal colonies are many and varied, and it was for the purpose of discussing some of these problems that the New York Academy of Sciences called a conference of the leading authorities on the subject. The seven formal papers and the discussions presented in this volume make up the proceedings of the conference, which was held in New York on November 10 and 11, 1944.

In the first paper, Hutt of Cornell University has discussed the genetic problems associated with the maintenance of animal colonies. The differences in nutritional requirements, resistance to disease, and other important physiological functions among different strains are emphasized. The investigator is advised to select his animals from those breeds or strains which have already indicated suitable qualities for his particular experiment, and to maintain the purity of his strains by the closest inbreeding possible for vigorous and productive stock.

The physiology of estrus, mating, and reproduction in laboratory animals is discussed by Hartman, of the University of Illinois. Here the problems of recognizing animal behavior in relation to sex physiology, and of the proper time for mating are emphasized. The wide variety of animals discussed is indicative of the richness of the fauna suitable for laboratory experimentation.

The feeding problems of laboratory animals are discussed thoroughly and competently by Loosli, of Cornell University. The importance of the various dietary factors for normal growth, reproduction, and resistance to disease is stressed.

The recognition, treatment, and prevention of a number of virus, bacterial, and parasitic diseases among laboratory animals are discussed by Ratcliffe, of the University of Pennsylvania. The necessity of screening out diseased animals, and of maintaining suitable environmental conditions in the animal colonies is indicated.

Because of the importance of room temperature in obtaining controlled conditions in animal experimentation, a paper on this phase of animal colony maintenance has been included. The effects of high temperatures in retarding growth, and the necessity for maintaining constant temperatures for optimal physiological performances are discussed.

The maintenance of the animal colony from the standpoints of (1) the university, and (2) the commercial breeder, is discussed in the last two papers. The initial costs of the animals and the breeding plant, respectively, and the problems of housing, feeding, and shipping are considered.

These papers present a good analysis of the problems involved in the maintenance of animal colonies in the United States. The need has been indicated for the standardization of animal strains, as well as for setting up a clearing house (perhaps in the National Research Council) for information regarding the availability of the various strains and types of laboratory animals. This bulletin will be read and appreciated not only by the people involved in the maintenance of animal colonies, but also by every investigator interested in the problems of controlled animal experimentation.

B. AUBREY SCHNEIDER

THE LIVESTOCK OF CHINA.

By Ralph W. Phillips, Ray G. Johnson, Raymond T. Moyer. U. S. Government Printing Office, Washington. 30 cents. vi + 174 pp. 1945.

At the request of the Chinese government, Phillips and Johnson spent the year of 1943 in making a preliminary survey of the domesticated animals of China. They were assisted by Moyer, longtime Director of an agricultural experiment station in Shansi province. This bulletin is their report. It describes the Chinese types of horses, donkeys, mules, camels, cattle, water buffalo, yaks and "pien niu" (yak-cattle hybrids), sheep, goats, swine, chickens, ducks, and geese. The management and feeding and the breeding of each of these kinds are also considered. There are numerous photographs, but they are very poorly reproduced. The authors conclude: "Most of the farm livestock and poultry are of rather primitive unimproved types." The respective advantages and disadvantages of (1) improvement by selection, (2) grading up, and (3) development of new types are discussed, along with inbreeding and hybridization. A solution of the conflict between the nomad and the farmer is keenly needed. Agriculture must be balanced between animal and crop production. Marketing control is of course another great need in China.

This bulletin should be useful as a reference on Chinese livestock for poultry and animal breeders, geneticists, and others interested. It should stimulate the Chinese to develop an important but neglected phase of their economy.

BENTLEY GLASS

ANIMAL MORPHOLOGY

HUMAN ANATOMY AND PHYSIOLOGY. *Second edition.*

By Nellie D. Millard and Barry G. King. W. B. Saunders Company, Philadelphia and London. $3.00. viii + 514 pp. 1945.

This is a good basic text for courses in combined anatomy and physiology. In the second edition it is a thin, streamlined, well-bound volume, printed in good type on durable paper,—unusual qualities in a wartime revision. It is lighter in weight and easier to handle than most books on this subject and so should prove popular with both instructors and students.

The general organization under five major units and the logical functional approach have been retained, as well as most of the original material. However, some notable changes have been made. The chapter on the Physiology of Muscle has been reorganized, and new material based on recent work has been included. The summary of factors influencing blood pressure has been presented in a new form. Many improvements have been made in Unit Five on The Nervous System; the section on cranial nerves, the material on the nerve impulse, and the chapter on The Autonomic Nervous System have been rewritten and expanded; the table summarizing the cranial nerves has been replaced by a new, more detailed one; the functional relationships of the various parts of the nervous system have been given greater emphasis by tracing each sensory mechanism.

One of the main improvements in the second edition is the inclusion of forty-five new illustrations by the artist, Lucille Cassell, which brings the number of original drawings up to 190. The diagrams and drawings are clearly labelled, and many have been made even more useful to the student by the addition of color.

It is the opinion of the reviewer, who has used both the first and second editions as texts in teaching cadet nurses, that the book is deficient in the following respects: (1) the description of bone development is not clear; (2) in some instances the use of many synonyms and unnecessary terms confuses the student; (3) the book lacks a glossary; (4) the chapter arrangement is not the best for beginners. However, instructors will find this text a valuable aid in presenting the subjects of anatomy and physiology.

BERNICE FRANCES PIERSON

THE CORTEX OF GALAGO. *Its Relation to the Pattern of the Primate Cortex. Illinois Monographs in The Medical Sciences, Vol. V, No. 3.*

By Gerhardt von Bonin. University of Illinois Press, Urbana. $1.50 (paper). 55 pp. 1945.

Galago is a lemur, of the family Lorisidae, and as such is, according to current ideas, a member of the most primitive group of Primates. Von Bonin has studied the cytoarchitecture of the cerebral cortex in a brain of *Galago demidovii* in order to check the validity of the proposed areal pattern of the primate brain and to obtain some hints about cortical differentiation.

A "pattern" is defined as a scheme of the spatial relationships between its constituent parts or "elements"—an abstraction that is meaningful only if derived from many instances. It is based on an "idealistic" morphology like that of Naef (1931), but is not a thing akin to Platonic "ideas." It avoids evolutionary or phylogenetic concepts and thereby the logical difficulties inherent in most of the problems of comparative morphology, which needs must rest upon a study of extant forms.

The areal pattern of the primate cerebral cortex is at present of great interest. Current concepts are based upon the studies of thalamo-cortical connections by LeGros Clark (1931) and Walker (1938) and the investigations of "physiological neuronography" by Dusser de Barenne and McCulloch (1938). A "sector" defines a particular cortical area in terms of its

afferent connections with a particular thalamic nucleus, whereas a "region" refers to a group of areas having a close functional relationship. The brain of *Galago* conforms to the primate pattern. Its rhinencephalon is relatively large. The sensory regions are well differentiated, the motor region less so, and the associational regions exhibit a very simple areal pattern. A homologue of Broca's area—"motor speech area"—in the inferior frontal convolution of the human brain is recognizable, however, in the galago as it is in all primate forms that the author has studied.

The author concludes that "it is of the essence of cortical organizations that sensory and motor areas become divorced more and more from each other—are pulled farther apart as it were—as evolution proceeds" and that "as we ascend the evolutionary scale, the cortex assumes increasingly a structure which may be interpreted as leading to increased degrees of indeterminacy."

This is a very interesting and stimulating study. In many respects it represents a refreshingly novel approach to one of the outstanding problems of comparative neurology.

W. L. STRAUS, JR.

BLOOD. *The Journal of Hematology. Volume I, Number 1, January, 1946. Bimonthly.*

Edited by William Dameshek, 25 Bennet Street, Boston. Published by Grune & Stratton, New York. $6.00 per volume (year); $7.50 foreign.

"Concerned with the advancement of knowledge of the blood and blood-forming organs and their disorders. Its aim will be to correlate the continuingly valuable but limited morphologic principles of the Old World school of hematology with the more dynamic physiopathologic standpoints that have vitalized the American approach in this field."

Leading papers to appear in early issues: The megakaryocytes in idiopathic thrombopenic purpura, with notes on pathogenesis of the disease, by William Dameshek and Capt. Edward B. Miller; Differentiation of pernicious anemia and certain other macrocytic anemias by the distribution of red blood cell diameters, by Geneva A. Daland, Clark W. Heath, and George R. Minot; The cardiovascular system in anemia, by Maxwell M. Wintrobe; Observations on the effect of massive doses of iron given intravenously to patients with hypochromic anemia, by Anna T. Goetsch, Carl V. Moore, and Virginia Minnich; Relation of contacting surface and anticephalin activity to the maintenance of the fluidity and coagulability of the blood, by Leandro M. Tocantins; The plasma proteins in relation to hemophilia, by F. H. L. Taylor and associates; Thiouracil agranulocytosis: report of eight cases with three fatalities, by Peter Vogel and Nathan Rosenthal; Primary congenital and secondary splenic panhematopenia, by Charles A. Doan; The treatment of liver extract sensitivity, by Steven O. Schwartz; Some newer concepts of the natural hemoglobin derivatives: I, General considerations; II, The erythrocyte protoporphyrins in the anemias, by Cecil J. Watson; The diagnosis of Hodgkin's disease by aspiration biopsy, by Lloyd F. Craver; Presentation of normal human plasma in the liquid state: V, Clinical and physiochemical studies during three years of storage, by Eugene L. Lozner, Sonia Lemish, A. Sue Campbell, and Lloyd R. Neuhouser.

ANIMAL PHYSIOLOGY

STUDIES IN BIOPHYSICS. *The Critical Temperature of Serum (56°).*

By Lecomte Du Noüy. Reinhold Publishing Corporation, New York. $3.50. (vi) + 180 pp. 1945.

This book reports results obtained from a long and carefully executed study of serum. The aim of these studies was to examine the mechanism of certain phenomena in the hope that an understanding of certain fundamental reactions of great importance to medicine, particularly for the diagnosis of infectious diseases, might be attained. The new hypothesis advanced in this work, as opposed to the classical concept of colloidal serum, is that of a serum molecularly dispersed, comprising albumin, globulins, lipoids, etc., in a true solution, either in a state of more or less fragile combinations or free. This newer hypothesis permits chemical interpretation and the introduction, among other concepts, of the idea of monomolecular oriented dispersion. The work dealt with in this particular volume is related to the fundamental problem of the nature of alexin, of the sensitizer, and of the mechanisms of the action of the complement. The book begins with an explanatory introduction and a summary of previous experiments concerned with adsorption and monomolecular layers. The following eleven chapters deal with various properties of serum as a function of temperature, namely, viscosity, rotatory power, rotatory dispersion, optical density (absorption), scattered light, factor of depolarization, ionic equilibrium (sedimentation, electrical conductivity, concentration of hydrogen ions), fixation of ether by serum, interfacial tension, and the ultraviolet absorption of serum. This work is a very interesting and valuable study of biophysical phenomena.

CHANDLER MCC. BROOKS

THE PHYSIOLOGY OF THE NEWBORN INFANT.

By Clement A. Smith. Charles C. Thomas, Springfield, Illinois. $5.50. xii + 312 pp.; 1 table. 1945.

This unique book deals with the physiological peculiarities of the infant just before and after birth. The brief period of development considered is of unusual interest to the physiologist because such remarkable changes occur suddenly at this time. Several systems of the body, respiratory, digestive, excretory, etc., begin their functions then. The neonatal and fetal aspects of respiration, changes in blood and circulation at birth, icterus neonatorum, the development of body temperature regulation, fetal and neonatal nutrition, renal physiology, neonatal endocrinology, and neonatal immunology are among the topics discussed. The book is exceptionally well organized, and very extensive bibliographies are appended to each section. It is a most creditable contribution to our knowledge of the physiology of man. The treatise is recommended to both clinicians and physiologists as a book which will well repay careful study.

CHANDLER MCC. BROOKS

ENDURANCE OF YOUNG MEN. *Analysis of Endurance Exercises and Methods of Evaluating Motor Fitness. Monographs of the Society for Research in Child Development. Volume X, Number 1 (Serial No. 40).*

By Thomas Kirk Cureton, Warren J. Huffman, Lyle Welser, Ramon W. Kireilis, and Darrell E. Latham. Society for Research in Child Development, National Research Council, Washington. $2.50 (paper). xxiii + 284 pp. 1945.

This study represents an attempt to analyze statistically a group of exercises which involve every principal muscle group in the body, for objective verification of the muscle groups which work together. Twenty-eight standard endurance type exercises were analyzed and compared as to their value for developing and testing physical fitness. Various psychological and physiological causes of improvement in the execution of tests were considered. The step test and Schneider's cardiovascular test of fitness were dealt with in great detail. The last chapter contains a final discussion of results and trends of research in the realm of endurance testing. This work should be of great value to those interested in physical education and the testing of physical fitness.

THE EFFECT OF ACTIVITY ON THE LATENT PERIOD OF MUSCULAR CONTRACTION. *Annals of the New York Academy of Sciences, Vol. 46, Art. 3.*

By Alexander Sandow. New York Academy of Sciences, New York. 50 cents (paper). Pp. 153–184; 3 plates. 1945.

This is a report of an experimental study of the processes occurring during the interval between stimulation of a muscle and its contraction. The treatise contains a description of methods used, results obtained, and a discussion of the implications of the data. Particular attention was given to the effects of a series of single twitches and series of tetani upon the latent period of frog skeletal muscle. The observed pre-contractile latency relaxation was thought to be a mechanical sign of the occurrence of a tension-induction process during which myosin is energized and activated for contraction.

SOME FUNDAMENTAL PRINCIPLES OF METABOLISM.

By L. H. Newburgh, M. W. Johnston, and J. D. Newburgh. Department of Internal Medicine, Medical School, University of Michigan; J. W. Edwards, Ann Arbor. $1.75. 63 pp. 1945.

The three sections of this book contain a simple and clear discussion of certain aspects of metabolism. The first of the sections is entitled "Energy" and deals with transformation of energy by the organism, the available energy of foods, direct and indirect calorimetry. A few brief statements are likewise made concerning a variety of topics such as superalimentation, undernutrition, fever, removal of heat, and the energy requirement of activity. The second section is entitled "Water" and contains a brief description of the sources of body water, water balance, and water excretion. The third chapter deals with "Extracellular Fluid." The composition of this fluid and the respiratory and renal regulation of its composition are discussed. Edema and certain abnormalities of electrolyte pattern are described. Practically all the information included in this volume is present in all modern textbooks of physiology. The aspects of metabolism selected for discussion are dealt with clearly and simply, but the book is totally inadequate as a source of information concerning numerous principles and fields of metabolic function.

CHANDLER MCC. BROOKS

ANIMAL NUTRITION

BIOENERGETICS AND GROWTH *With Special Reference to the Efficiency Complex in Domestic Animals. (A Publication of the Herman Frasch Foundation).*

By Samuel Brody. Reinhold Publishing Corporation, New York. $8.50. xii + 1023 pp. 1945.

The author's long tenure of the generous Herman Frasch Foundation grant proved an adventure in science and philosophy. The many *Growth and Development* contributions, familiar since 1926 to students of growth, are now oriented to each other and to knowledge in general, the latter including religion, the maintenance of man's place on earth, changes in civilization, and other ideas discovered along the paths of the investigations. The central theme is

homeostasis, or how the organism, or society, persists amid disturbing forces. Knowledge of metabolism, growth, ageing, food production, efficiency and work is extended through new information and integrating discussions.

Brody first defines efficiency, long and short range profit, growth, and the thermodynamic concepts used in the research. He and his colleagues at the Missouri Agricultural Experiment Station have a lively sense of responsibility for a better agricultural industry, and many practical recommendations are included. To determine efficiency is to aid understanding, increase food production, and improve the lot of man.

Food, the source of animal energy, is partly usable waste, partly used for physiological net energy and partly lost from "entropy tax" (extra heat due to the metabolic process itself). The physiologically useful energy is used for growth in non-mature organisms, reproductive products, and byproducts (milk), and for maintenance. How these are measured and separately analyzed fills many detailed pages of interesting and informative reading. The findings for domestic animals are related to corresponding information for man. Engineering problems were surmounted on a scale unknown in the medical laboratory, e.g., the rumen of a well-fed cow can produce 300 liters each of CH_4 and CO_2 per hour, and respiration may involve 2400 liters per half hour—to say nothing of gaining the confidence and cooperation of the animal. Gross efficiencies, including maintenance, are 60 per cent for prenatal, 35 per cent for early postnatal, and 5–10 per cent for late postnatal growth of beef, 16 per cent for egg production and 33 per cent for milk production. A superior cow may produce milk at an efficiency of nearly 50 per cent! Net efficiencies are all about 60 per cent.

The importance and the effects of different levels of nutrition were determined for growing and mature animals. The law of diminishing returns is believed to limit most biological functions. Vitamins are considered endogenous, hormones exogenous catalysts, and about 100 pages summarize recent knowledge of them, of minerals and of enzymes. Seasonal and diurnal rhythms are discussed. Chapter 10, on homeostasis and organismic theory, integrates the discussion by means of a theory of a living field, which is dynamically constant, remains until the homeostatic mechanisms break down, and the animal dies. Religion, as a homeostatic mechanism, is observed to function less well in recent years, and Brody suggests that it be investigated scientifically on a characteristically human level to set it aright, so that leaders may use the increasingly powerful tools for peace.

Five chapters describe calorimetric methods and relate metabolism to temperature, size, and weight. Dimensional analysis is used effectively. From the literature cited and from present measurements, the best value for basal metabolism to weight was found to be the 0.7 power, which holds from a 0.02 kg. mouse to a 4000 kg. elephant. Changes in metabolism with age and size are discussed for man, and farm and laboratory animals.

The time relations of the growth of individuals and populations, linear growth, form, function, physiological age (time), and senescence are treated in 250 pages. (It is unfortunate that the error of days instead of hours is perpetuated in the yeast growth curve.) Population data are taken from others, and this discussion is inferior to that based on the first-hand experimental data. The allometric equation is used for both chemical and morphological data. Pre-inflectional time-growth is expressed with respect to that already accomplished by the equation $y = Ae^{kt}$ and post-inflectional growth with respect to the growth yet to be made by using $y = A - Be^{-kt}$. No tests of goodness of fit were made. Rather than fitting the growth data *in toto*, straight line segments were often used. More complicated equations are eschewed as being undesirable and unnecessary. An implication of rationality is given to the equations, although on p. 263 the limitations of such equations are stated fairly. The possible use of orthogonal polynomials might have been considered. Other theories of growth receive scant consideration, and little attempt is made to answer the criticism prevously levelled at the segmental type of analysis. The reviewer would rather have had less space used for the more than 200 graphs in this part of the book, and more devoted to the penetrating discussion.

The remaining 234 pages include a consideration of the nutritional aspect of efficiency; of nutrition; of social, physiological, and financial aspects of milk and egg production; of the efficiency of muscular work; and conclusions. Chapters 20 and 21, dealing with nutrition and milk, should be read by all persons concerned with their individual and national standards of living. Milk is produced efficiently from materials not otherwise useful for nutrition and enriched with vitamins. It is too often skimmed and fed to animals who do not need it, instead of being used to lessen human malnutrition. Brody's constructive criticisms of nutrition in modern civilization should be studied and utilized for the good of mankind. The summary briefly restates the major contributions of the research program and integrates them with modern living conditions. The unfortunate trend from rural to urban communities is examined. Brody closes on an optimistic note that science could be used to guide individual and social development to realize the promises of religion. Since his book went to press, atomic developments promise either greatly to accelerate such a program, or to eliminate any need for it.

Typographical errors are few. Many new data and much published material are made conveniently available in this encyclopedic volume, which is documented with about 2000 footnote references. Nu-

merical data are given in appendices (up to 22 pages in length) to many of the chapters, thus inviting the skeptical reader to make his own analyses. The hundreds of analytical graphs and illustrations are excellent; few are overcrowded. Many opportunities for research are proposed. Comprehensive author and subject indexes are provided. Some readers may find the quick changes from exacting science to philosophical speculation delightful; some will find them confusing, or annoying. If this extra material reduces the practical use of the information in agriculture, biology, and sociology, it will be unfortunate. Specialists will disagree vigorously with some of Brody's conclusions, but in any case his book will stimulate thought and become a useful and valuable addition to our bookshelves.

OSCAR W. RICHARDS

THE DIETARY OF HEALTH AND DISEASE. *Fourth Edition.*

By Gertrude I. Thomas. Lea and Febiger, Philadelphia. $3.50. 308 pp. 1945.

This book has been written as a text book for the course in nutrition for the student nurse. The fourth edition has been revised to include recent developments in the field of nutrition. The book contains 27 chapters on various topics. The first nine chapters deal with the science of nutrition, and include a general introduction, processes by which the body makes use of food, the vitamins, minerals, water and cellulose, carbohydrates, the lipids, proteins, and metabolism. Following these chapters, there are two chapters discussing the Economic Aspects of Nutrition and Society and Nutrition. Then follow 16 chapters on various aspects of dietetics for nurses. These include information on dietary conditions of the sick, the various kinds of foods and food mixtures, recipes for special foods for various age groups and individuals with abnormal health conditions, menus for various conditions, and diet therapy.

The chapters are short, the statements of information are concise, and details are omitted. In the majority of cases the information is adequate, since other courses of the nursing curriculum supplement the course in nutrition and foods. The organization of the chapters is not too satisfactory, and they contain some information irrelevant to the subject of the chapter. As an example of this, it was noted that a discussion of lymph and blood, with a table of Blood Composition, was included in the middle of the chapter on Proteins.

The topic of each paragraph is printed in capital letters, making things simple for the student. Included are excellent tables on vitamins and food composition. Charts show the comparative composition of foods with respect to each constituent. A bibliography is included at the end of each chapter. The appendix includes an outline for a 70-hour course in nutrition for the student nurse and should be most helpful to the instructor in the course. On the whole, the book should be a fairly satisfactory text for the course in Nutrition and Foods for the student nurse.

MARGUERITE M. SCHMIDT

THE USEFUL SOYBEAN. *A Plus Factor in Modern Living.*

By Mildred Lager. McGraw-Hill Book Company, New York and London. $2.75. xii + 295 pp. 1945

Although the soybean was introduced into this country from the Orient about 140 years ago, it has come into its rightful place in our economy only during the past 25 years, and then only as a result of the impact of two world wars. A more versatile plant than the soybean has probably never been grown; its products cover an extremely wide variety of foods and industrial compounds. The secret of its versatility both as a food and as an industrial product lies in its vitamin, protein, and fat content.

In this very enlightening and entertaining little volume, the author has written not only of the history and the romance of the soybean, but of the vast possibilities of its future in our world economy. The use of the soybean in soil improvement, diet improvement, and the manufacture of countless commercial products is discussed with authority and clarity.

The last 100 pages of the volume are devoted to recipes for using the soybean and a wide variety of its products in everyday meals and general cooking. Although a few of the recipes maintain an oriental flavor, the majority are based on American appetites and methods.

The text is supplied with a number of photographs, charts and tables, and a full index.

B. AUBREY SCHNEIDER

BIOCHEMISTRY

THE CHEMISTRY OF LIFE. *An Easy Outline of Biochemistry. The Thinker's Library, No. 103.*

By J. S. D. Bacon. Watts and Company, London. 2s. 6d. ix + 118 pp. 1944.

One would expect a book with this title to be a much larger volume but, as indicated, the author has packed in the 110 small pages an outline of the field of biochemistry. No attempt has been made to present historical aspects, the names of investigators, or even all of the facts that are known. The treatise deals rather with the logic behind the main facts and techniques, and sometimes raises questions that stir the imagination, to say the least. The many unsolved

problems are brought to the attention of the reader.

The chief asset of the book is its simplicity and clarity. With the aid of the 8-page glossary at the end, the average layman could read and understand most of the book. It is, however, more likely to appeal to scientists who have not specialized in biochemistry and to students who are just entering this field. There is no index and no bibliography.

FRANK H. J. FIGGE

PHOTOSYNTHESIS AND RELATED PROBLEMS. *Volume I: Chemistry of Photosynthesis, Chemosynthesis and Related Processes in Vitro and in Vivo.*

By Eugene I. Rabinowitch. Interscience Publishers, New York. $8.50. xiv + 599 pp. 1945.

This volume is divided into two parts: I, The Chemistry of Photosynthesis and Related Processes; and II, The Structure and Chemistry of the Photosynthetic Apparatus. A second volume, including Part III, The Spectroscopy and Fluorescence of the Pigments, and Part IV, The Kinetics of Photosynthesis, is promised in the near future.

Willstätter and Stoll (1918), Bose (1924), and Baly (1940) have written books on the subject of photosynthesis which are essentially records of their own investigations and conclusions, although they include more or less discussion of the work of other investigators. Stiles (1925) and Spoehr (1926) undertook to review the subject as a whole, in the light of the experimental evidence accumulated up to that time. Rabinowitch, like Stiles and Spoehr, has given us a general review of the subject, but as he says, he has placed "increased emphasis on physical and physicochemical methods and theories." He has given special attention to developments of the last twenty years, and refers the reader to Stiles and Spoehr for fuller discussions of earlier work. However, Rabinowitch gives considerable space to discussion of many classical papers from the nineteenth century, especially those having some relation to more recent research.

Although photosynthesis is generally regarded as a botanical subject, its cosmical importance has drawn the attention of investigators from many fields, and papers dealing with various aspects of the subject are scattered through a great number of scientific journals. A comprehensive review is therefore a large undertaking. The author of this volume, a member of the Solar Energy Conversion Research Project at the Massachusetts Institute of Technology, informs us in the preface that his interest in photosynthesis dates only from 1937. He displays a breadth and thoroughness of understanding of the subject which would do credit to one who had worked intensively in the field for a much longer span of years. This book is evidence of remarkable ability and industry on the part of the author.

During the last five or ten years, those who work in the field of photosynthesis have felt an increasing need for a new survey of the subject in book form. Since the publication of Spoehr's monograph in 1926, there have been a number of outstanding developments in photosynthesis and allied fields. For example, the work on purple bacteria, and the discovery that external carbon dioxide participates in the metabolism of heterotrophic as well as autotrophic organisms, have resulted in the application of concepts of comparative biochemistry to photosynthesis. Conclusions drawn from the study of photosynthesis in intermittent light have modified our opinions concerning the relationship between photochemical and enzymatic steps in the process. The use of radioactive tracer elements has brought about a fundamental modification of our views concerning the chemical mechanism of photosynthesis. Renewed efforts have been made to interpret experimental observations in terms of chemical kinetics. And the conclusion drawn more than twenty years ago by Warburg and Negelein that green algae were capable of reducing carbon dioxide with an efficiency of one molecule for each four absorbed quanta of visible light has been rejected as a result of convincing evidence that eight or more quanta are required per molecule of carbon dioxide. While these and other developments have been discussed from time to time in review articles, the need for a more comprehensive treatment has remained. This volume will be a welcome asset to those who are engaged in research on photosynthesis, whether their background is biological, physical, or chemical, for Rabinowitch has presented the material in such a way as to bring out the significance of the contributions from these various branches of science.

To those whose primary interest is in teaching, or in fields of research not directly related to photosynthesis, the volume offers valuable material that is not available elsewhere in book form, although many of the chapters are too specialized to be of much interest to the general reader. In the reviewer's opinion, the principal value of this book to the general reader lies in its emphasis upon the remarkable capacity of the green plant for the accumulation of energy. If there may be said to be a core around which the contents of the book are organized, it is the problem of energy accumulation. Although it is common knowledge that photosynthesis is strongly endothermal, the ability of the plant to carry out this process with the energy obtained from absorbed visible radiation is not generally recognized as the remarkable achievement which it really is. The energy required per molecule of carbon dioxide converted to carbohydrate exceeds by a factor of 3 or more the energy available per absorbed quantum of red light, so it is clear that the plant must accumulate the energy from several individual absorptions, in order to carry out the conversion. Since, as Rabinowitch says in the first paragraph of the pref-

ace, no mechanism capable of such an achievement is known outside the living cell, this problem of energy accumulation is the most baffling aspect of photosynthesis. Recognition of these facts by physicists and physical chemists has tempted them to face the practical difficulties of biological research, while biologists for the most part have failed to realize the theoretical difficulties facing those who seek to formulate a satisfactory interpretation of this process which they accept as an every-day occurrence.

Rabinowitch, like Spoehr, begins with a discussion of the cosmical importance of the carbon cycle, and in the second chapter he gives a condensed account of the discovery of photosynthesis. These chapters present old material with a fresh viewpoint, and serve to introduce the general reader to the subject. To the reviewer it seems regrettable that the classical experiment of van Helmont is not mentioned, but Priestley and Robert Mayer are given fuller discussion than in Spoehr's book, and perhaps this compensates for the omission of reference to van Helmont.

The arrangement of the remaining chapters is necessarily somewhat arbitrary, because there is as yet no generally accepted concept of the nature of the photosynthetic process, around which a logical sequence of chapters could be built. While the author has been careful to emphasize the interrelation between the various aspects of the subject whenever possible, such relationships are often problematical, and cannot be expected to give a strong thread of continuity. Most subjects are presented on an individual basis, with a formulation of the issues involved, a discussion of the experimental evidence and its bearing on conflicting theories or hypotheses, and (usually) a brief statement summing up the author's attitude toward the present status of the subject. The author has used restraint in drawing conclusions, and has been impartial in the presentation of evidence. Even such fantastic claims as those of Dhar and Baly concerning their achievement of photosynthesis *in vitro* are not dismissed without receiving a fair presentation and a discussion of refuting evidence (pp. 85–89).

In the reviewer's opinion the author may have been somewhat too tolerant of the frailties of biological research. Living material is subject to an uncertainty of behavior of a different order of magnitude from that encountered in chemical and physical research. This uncertainty of behavior places upon experimental biologists a responsibility for giving exceptional attention to controllable variables, and the extent to which different investigators have accepted this responsibility is far from uniform. To a biologist, it is hardly surprising that a careful examination of conflicting evidence often leads to no decisive conclusion. The sympathetic consideration which the author has given to practically all relevant material since 1925 seems in some cases to be only barely justifiable, and indeed the author himself implies this in the preface.

Many features of the book could be singled out for special commendation. In Chapter 6, the presentation of Gaffron's work on hydrogen assimilation by green algae and related phenomena is much clearer than in the original papers. The discussion of phosphorylation and carboxylation in Chapter 9 will be of interest to a wide audience in addition to those primarily concerned with photosynthesis. The table on p. 447, showing the basis for the nomenclature of the derivatives of chlorophyll, will be helpful to those who find the relationship of these substances confusing.

One wonders, in connection with the discussion on pp. 332 and 569, why there is no reference to Holman's work on solarization. The index would be improved by the use of heavy-faced type for the principal page references to important subjects. Because of the many page references to some subjects, the reader wishing to locate the principal discussion of a given subject may find it easier to refer to the table of contents than to the index. The arrangement of literature references at the ends of chapters in chronological rather than in alphabetical order must have been done for good reason, but it makes the location of references by author's name difficult. The book contains a regrettable number of typographical errors, incorrect page and literature references, and minor instances of poor English usage, such as frequent substitution of "would" for "should" or "could." However, hardly any of the errors are such as to detract from the uniformly high level of clarity of presentation.

ROBERT EMERSON

ANNUAL REVIEW OF BIOCHEMISTRY. *Volume XIV. Edited by James Murray Luck and James H. C. Smith. Annual Reviews, Inc., Stanford University P. O., California.* $5.00. x + 856 pp. 1945.

This year's *Annual Review of Biochemistry* is the largest that has been published thus far. It contains 28 reviews written by 40 contributors. A short book review cannot do justice to such a volume, and it would be pretentious to assume that one individual could critically and justly evaluate all this material, which deals with so many special fields of biochemistry. An attempt will be made to discuss only the reviews that appear to be more than annotated bibliographies, and those subjects that would be of interest to biologists in general.

The review of "Biological Oxidations and Reductions" was written by Lardy and Elvehjem. The iron porphyrin-containing enzymes and carriers are discussed first. In this the obsolete term hematoporphyrin is used in place of protoporphyrin. It is a trivial point, but it was shown approximately 20 years ago that hematoporphyrin is an artificial decomposition product of hemoglobin which probably does not occur in nature and certainly would not be formed in

the synthesis of hemoglobin, catalase, or any other heme-containing substances. It will be a step forward when some of the biochemists in this country stop using this obsolete term. In addition to the discussion of the heavy metal protein enzymes and dehydrogenase and oxidase systems, a variety of other mechanisms of oxidation and reduction were included.

The reviews on proteolytic and non-proteolytic enzymes follow the pattern of previous years. The chapter on amino acids and proteins by Steinhardt gives an excellent review of the progress that has been made in studies on protein structure and denaturation. The discussion of recent work in the field of nucleic acids and nucleoproteins will interest geneticists, virologists, and oncologists. Fankuchen has given an excellent critique of the methods used in x-ray studies, followed by a critical integrating review of the work on the structure of various proteins, starch, sterols, and bone.

The current interest in the chemistry and metabolism of the compounds of phosphorus is reflected in the review by Kalckar. According to this, a number of improvements in the methods of determination of both phosphate and phosphatases have been devised. The accumulation of quantitative data on the metabolism of phosphorus compounds is advancing rapidly. The review of the metabolism of proteins and amino acids begins with the statement: "The mechanisms of intracellular protein synthesis continue to remain obscure." The discussion of the metabolism of individual amino acids occupies the main part of this section. The chapter on mineral metabolism reveals some rather striking advances in our knowledge of gastric secretion and urinary calculi formation. The chapters on nutrition and vitamins include 130 pages and contain 877 references. This reflects the vast amount of work being done in this field.

Salter's discussion of recent work on the chemistry of hormones is excellent. This contains many references to work dealing with the purification, synthesis, and intermediary metabolism of these important substances. The review of work on animal pigments is limited almost entirely to heme pigments. Considerable space is wasted in seemingly unnecessary quibbling over unfortunate trends in terminology. There is, however, a good discussion of the structure of "haemoglobin." The review of "The Biochemistry of Malignant Tissues" by Greenstein is short, but one of the best. In the sixteen pages devoted to this, he has presented as clear a picture of this field of investigation as one will find. It can be highly recommended. The chapters on the chemistry of bacteria and of antibiotic substances, other than penicillin, are timely, and the reviews are well done.

FRANK H. J. FIGGE

ADVANCES IN CARBOHYDRATE CHEMISTRY. *Volume I. Edited by W. W. Pigman and M. L. Wolfrom. Academic Press, New York.* $6.00. xii + 374 pp. 1945.

This is the first of a series of annual volumes to be called *Advances in Carbohydrate Chemistry*. The contributors are to be selected from research workers in this field. They will be invited to write critical integrating reviews of the developments in their special field. These reviews are to be written not only for chemists in the broad field of carbohydrates, but are designed to be useful also for the general chemist as well as research workers in other fields. The plan to have contributors furnish critical integrating reviews, rather than mere literature surveys, has been accomplished in this first volume. The name "Advances" was doubtless chosen in preference to "recent advances" in order to permit the inclusion of thorough reviews of fundamental topics which could not be called "recent." This decision was especially important from the point of view of biologists and workers in other fields of chemistry.

The paper on the Fischer cyanohydrin synthesis, by Hudson, is a good example of the excellent results that may be obtained by a review of the fundamental historical aspects, followed by a consideration of the more recent application of this principle in the synthesis of higher-carbon sugars and alcohols. The chapter on the "Altrose Group of Substances" by Richtmyer is essentially a complete review of all that has been done with this group of substances and their derivatives since the synthesis of d-altrose and d-allose from d-ribose in 1910. The subject of carbohydrate orthoesters is discussed by Pacsu. It is one that will interest only specialists in this field. The short paper on thio- and seleno-sugars by Raymond covers both old and recent work on these rare sugars. The discussion of cardiac glycosides by Elderfield is limited to the more rare carbohydrate components: digitoxose, digitalose, cymarose, diginose, oleandrose, and sarmentose. The chemistry and preparation is given for all of these sugars.

The chapter on the metabolism of sugar alcohols, by Carr and Krantz, is a historical survey coupled with an excellent account of recent advances which includes a summary of their own extensive work in this field. It is well organized. The following chapter on the chemistry of nucleic acids, by Tipson, should be popular with biologists, biochemists, and general chemists. It was included in this work on carbohydrates by virtue of the ribose component of nucleic acids. The review concentrates on this carbohydrate portion of the molecule, but considers the other portions in sufficient detail to make it an excellent account. The next two chapters deal with the fractionation of starch and the preparation and properties of starch esters. The cellulose esters of organic acids are dis-

cussed by Fordyce. This contribution covers mainly the basic chemistry of methods involved in converting cotton to textiles, films, and plastics, and in other industrial applications. The final chapter, on plant polyuronides by Anderson and Sands, outlines the methods used to isolate, purify, analyze, and identify plant pectins, gums, and mucilages. The 17 pages of index, representing 5 per cent of the book, appears adequate.

FRANK H. J. FIGGE

LECITHIN. *Arzneimittelforschungen, Band 1. By Rudolf Kunze, with the collaboration of H. C. Buer. (Rosenmeier and Dr. Saenger K.-G., Berlin); J. W. Edwards, Ann Arbor, Michigan.* $3.25. 166 pp. (1941); 1945.

This is an excellent monograph written in German on lecithin. It is carefully prepared, and no detail has been omitted. This explains why it has been lithoprinted. Some concept of its completeness may be gained from the fact that sixty-eight pages are devoted to the chemistry and physical chemistry of lecithins. The practical aspects, such as the influence of lecithin on the permeability of cell membranes, are emphasized.

In the next section, the occurrence and quantitative distribution of lecithin in various animal and plant tissues are discussed. The remainder of the book is devoted to the physiological activity and possible therapeutic uses of lecithin. This section begins with a general discussion of the physiology and metabolism of lecithin and then takes up its specific effects on various types of cells and tissues. In this discussion, there appears to be some over-enthusiasm for the therapeutic possibilities. The following is an abstract of the author's summary: Lecithin acts as a go-between in the case of both water and fat solvents and thus influences the structure of protoplasm. It regulates the permeability of cell membranes and thereby total metabolism; and influences especially such factors as oxygen consumption, acid base balance, carbohydrate, fat, and protein metabolism. Lecithin has vitamin characteristics, stimulates growth, development, and increases the subjective well-being and resistance of the organism. It influences the blood picture and blood formation. Lecithin stimulates phagocytosis by leucocytes, mediates the action of hemolytic poisons and, on the other hand, detoxifies many other poisons. It influences the performance of heart muscle, antagonizes the deposition of cholesterin in the vessel walls and the formation of gall stones. Lecithin forms a major portion of the nerve substance and takes a part in the nerve metabolism. It bears a relation to the function of almost every gland, especially the gonads, and has, in the case of certain hormones, a synergistic, and in the case of others an antagonistic, action. Lecithin is thus heralded as a natural drug, and its therapeutic possibilities are fully discussed.

This is a very informative and carefully organized book. The bibliography at the end of each section indicates that the literature was thoroughly covered, and it should, therefore, be an excellent reference.

FRANK H. J. FIGGE

FLUOROCHEMISTRY. *A Comprehensive Study Embracing the Theory and Applications of Luminescence and Radiation in Physicochemical Science. By Jack De Ment. Chemical Publishing Company, Brooklyn.* $14.50. xvii + 796 pp. 1945.

This is a difficult book on which to comment. It has some good points, but many bad ones. A forbearing attitude will be adopted in this review because the author, according to a statement in the preface, is young. The almost nauseating, sophomoric, and egotistical attitude which he displays in the very beginning of the book is, perhaps, more easily overlooked in one so young and scientifically apparently somewhat precocious. The wise counsel of a mature, older associate was apparently lacking, according to this paragraph in the preface. It deserves quotation, since it is the only indication that the author may possibly have been aware of some of his limitations and defects: "Other than the gratuitous help provided by the aforementioned students and investigators, all of the effort which has gone into the preparation of this book is the result of my own work. Many of the concepts which I have endeavored to present lucidly have never been spoken aloud. The exigencies of life have made it seem at times that this work would not develop beyond even preliminary stages, and I have been genuinely, even painfully, aware of the vagaries of a mind by itself: Yes, at twenty-two, one can sometimes be inordinately conscious of the vacancies within his mental structure." (De Ment, 1944).

The first two pages of the book are devoted to muddled definitions of the terms luminescence, fluorescence, and phosphorescence. In some respects, the definitions do not agree with those given in other books on luminescence or even with the definitions given in the appendix of his own book. Such careless verbosity occurs throughout, and in many places one is forced to wonder whether the author really understands some of the statements that he has copied and paraphrased.

In spite of De Ment's desire to create something more than an extensive collection of facts regarding fluorochemistry, he has failed to do so. This is partly related to his attempt to exaggerate his own questionable contributions. These contributions (De Ment's Fluorescence Laws) consist mainly in restating certain

self-evident facts which have been regarded as corollaries of Stokes' Law and referred to as such for the past 90 years by other workers in this field. For example, one frequently finds in other books and papers, the general statement that in order to excite photo-luminescence, light must be absorbed. This is regarded as sufficient space to devote to such a self-evident fact. De Ment, however, treats this in the following manner: "*The First Law of Fluorescence*" (capital headlines) "The De Ment Absorption Law" (Heavy dark heading) and then the paragraph begins: "In 1942, J. De Ment enunciated the fundamental principle underlying all processes of a luminescent nature. Based on theoretical considerations alone, the first law of fluorescence states that before emission can occur from a luminescent system, absorption must take place. De Ment's rule is the analog of the Grötthuss-Draper law of photochemistry, which has made possible great advances in knowledge about the effects of light on chemical reactions" (p. 2). The rather lengthy and detailed discussion of this axiomatic relationship could be excused, but the attachment of one's own name to such a trumped-up so-called law is ultra-egotism that cannot be condoned at any age. What might have been a good book is thus marred in countless places by the author's repeated and misguided attempts at self-election to fame.

In an unguarded moment, Stokes was given credit for what is termed the *second* law of fluorescence—the Stokes' emission law. This states that: "The energy released as luminescence from a body is always less than the energy absorbed for initial excitation" or rather that the emitted light is always of longer wave length than the exciting light. Only a single page is devoted to this law and its "violations."

The third law of fluorescence is also De Ment's brain child, according to the author, but this would be regarded by most physicists as another corollary of Stokes' law. The derivation of this "law" was described as follows: "By employing a line of reasoning paralleling the Einstein law and luminescence efficiency, J. De Ment in 1943, postulated the 'luminescence-equivalence' concept which comprises the third law of fluorescence" (p. 8). In the following pages, there is included a table on the efficiencies of luminescence of certain dye solutions as determined by another investigator. The headings for two of the columns appear to be transposed, because the list of wavelengths indicating emission maxima are all shorter than those listed for absorption maxima. This is doubtless an oversight in proof reading or in copying, but again reflects carelessness.

The book does contain a wealth of data on the fluorescence of organic and inorganic compounds, dyestuffs, minerals, glasses, and plastics. The chapters on ultra-luminescence or ultra-violet-emitting substances and on infra-red fluorescent radiations also contain much material. This abundance of material is somewhat undesirable, as it indicates that it was not critically evaluated and selected. In the chapters on fluorobiology at the end of the book, the author has gone so far beyond his field that errors and confusing statements reign supreme. If the literature citations in this book are more accurate than those found in other books by this author, it may have some value as a reference volume. However, some parts of the book should be read only when a strong emetic is required.

FRANK H. J. FIGGE

IMMUNO-CATALYSIS.

By M. G. Sevag. Preface by Stuart Mudd. Charles C. Thomas, Springfield, Ill. and Baltimore, Md. $4.50. xv + 272 pp. 1945.

Most scientific literature may be readily classified into special groups of subjects. This particular treatise deals with two distinct fields of thought, and the author is to be particularly commended for his effort to bring together enzymological and immunological information. The subject with which the book deals is the immune reaction, the mechanism of which is explained in terms of enzyme chemistry. The theory is proposed that antigens behave as catalysts or enzymes, and that antibodies correspond to the inhibitory by-products of many chemical transformations. Data are presented showing that antibodies are produced in quantities far out of proportion to the amount of antigen necessary to elicit response, and that antigens do not appear to enter into the formation of antibodies. Considerable evidence is brought forward to demonstrate that the neutralizing action of antibodies on their homologous antigens parallels the inhibiting action of products of catalysis. Antibodies against plant and animal enzymes, snake venoms, bacterial toxins, and enzymes are discussed.

There are inadequacies of such a theory, at least in the present state of knowledge. Some of these are discussed by the author. For example, the specificity of antibody response to species-specific proteins, in the case of the hemoglobins, is considered at some length.

The presentation of material is clear and careful. Whether or not the reader agrees with the hypothesis of immuno-catalysis, and whether or not future evidence will support or contradict the theory, the book forms an interesting contribution to the literature of immunology and is well worth the reading.

HARRIETTE VERA

MICROBIOLOGY

TEXTBOOK OF BACTERIOLOGY. *Fourteenth Edition, Revised.*

By Edwin O. Jordan and William Burrows. W. B. Saunders Company, Philadelphia and London. $7.00. xvii + 909 pp.; 2 tables. 1945.

This important and widely used text has been revised throughout and in the process of revision has been made more practical. For instance, in each of the sections on types of infectious organisms there has been included a brief summary of diagnostic procedures. A great many new illustrations have been used. There are maps showing the geographical occurrence of widespread diseases, such as typhus and plague. There are more tables and charts. A good deal of information concerning recent work on bacterial nutrition has been inserted. Many of the chapters, e.g., those on cholera and *Rickettsiae*, have been considerably expanded, and several have been almost entirely rewritten. In the discussion of the *Salmonella* group much more information on antigenic components has been given. The chapters on mycology, parasitology (written by R. J. Porter), and spirochetes have a great deal of added material. Metazoan parasites are included with the protozoa, making the text more useful for the bacteriologist practising diagnostic work, since this was an outstanding omission from previous editions.

The changes in the text have been chiefly additions and, as a result, the book is considerably larger. It is well printed and attractive, and in several respects is an improvement over the last edition of an even then excellent book. It is now both more up-to-date and more comprehensive in its handling of the subject matter.

HARRIETTE VERA

INJURY AND DEATH OF BACTERIA BY CHEMICAL AGENTS. *No. 3 of the Biodynamica Monographs.*

By Otto Rahn. Biodynamica, Normandy, Missouri. $3.60. 183 pp. 1945.

When subjected to any of a variety of injurious agents (chemicals, radiation, heat) bacteria lose their reproductive capacity at a rate such that the fraction of cells affected is constant for equal periods of exposure to a given concentration of the agent. This results in what is often called the "logarithmic order of death." In the case of radiation, which has been most thoroughly studied, the fraction of cells damaged depends only on the total amount of radiation received. This is best interpreted by assuming that the biological effect is the result of a change (comparable to a mutation) in some discrete element of the cell, produced directly by the local absorption of radiation energy. These considerations are well known to those working in radiation genetics.

Logarithmic orders of damage can hardly be explained by variability in the sensitivity of the individual cells of a population. Rahn has been a pioneer proponent of the "mutation" versus the "variability" interpretation of the logarithmic order of death in bacteria, and emphasizes this point anew both in the monograph here reviewed and in a recent review on "Physical Methods of Sterilization of Microorganisms" (*Bact. Rev.*, 9: 1–47. 1945). Rahn's discussion should prove useful in dispelling a confusion on this point that has lasted surprisingly long among bacteriologists.

It is regrettable, however, that the author's crusading enthusiasm for his interpretation of the death rates has led him to a rather one-sided and unbalanced treatment of his subject matter. The book consists of two parts—the first dealing with the logarithmic order of death, the second with the mode of action of disinfectants and antiseptics—and a bibliography including about 200 references.

The extremely detailed discussion of the formal mathematical interpretation of the death rates is not matched by an adequate attempt to interpret the material in terms of the life processes of bacteria. The important effects of temperature and of concentration of the chemical agent are not adequately interpreted. The presence of complicated temperature and concentration effects in the case of the action of chemicals indicates the existence of recovery processes and probably a relationship between primary reaction and lethal reaction less direct than in the case of radiation experiments.

The chapter on disinfectants includes the outline of a test proposed by the author for their standardization. In the chapter on antiseptics, a clear discussion of the mode of action of sulfonamides oversimplifies the relation between sensitivity to these compounds and ability to synthesize p-aminobenzoic acid. Other pertinent work on analogues of essential metabolites is hardly mentioned.

Most puzzling to the biochemist will be a series of definitions of "cell mechanisms" (p. 10) establishing a quite arbitrary distinction between enzymes, catalysts, nuclear apparatus, and cytoplasmic proteins. We are surprised to find myosin listed among the proteins "without definitely known physiological function."

In spite of the shortcomings apparent to this reviewer, the book should play a useful role in interpreting for workers in the field of applied bacteriology the modern conceptions of the mode of action of disinfectants and antiseptics.

S. E. LURIA

DIE BAKTERIOLOGIE DER SALMONELLA-GRUPPE. (*Typhus-Paratyphus-Enteritis-Gruppe.*)

By F. Kauffmann. (Einar Munksgaard, Kopenhagen); J. W. Edwards, Ann Arbor, Michigan. $7.25. 393 pp. (1941); 1945.

Dated December, 1940, this comprehensive study by an authority in the field has only recently been published in this country, and its main deficiencies would appear to be due to this unfortunate delay. However, the book is undoubtedly an important contribution and will prove to be a valuable asset for those bacteriologists and immunologists interested in enteric infections.

As might be expected, the consideration of media and cultural methods is rather limited, especially in comparison with methods in current use in the United States. Most of the text is devoted to serology and a description of antigenic types and species. Because of components common to those of *Salmonella*, five types of *Salmonella coli* (regarded here as belonging to the *Escherichia*) are described. Diagnosis, pathogenicity, epidemiology, and control of salmonellosis are discussed. The concluding chapter states some outstanding problems concerning these bacteria and the infections caused by them.

The book is well made up. Subjects and subheadings are clearly marked, and it is relatively simple to find information in the text although there is no index. The bibliography is extensive.

HARRIETTE VERA

A HITHERTO UNDEMONSTRATED ZOOGLEAL FORM OF MYCOBACTERIUM TUBERCULOSIS. *Annals of the New York Academy of Sciences. Vol. XLVI, Art. 2. By Eleanor Alexander-Jackson. New York Academy of Sciences, New York.* 50 cents (paper). Pp. 127–152; 6 plates. 1945.

HEALTH AND DISEASE

TEXTBOOK OF HEALTHFUL LIVING. *Third Edition. By Harold S. Diehl. McGraw-Hill Book Co., New York and London.* $2.50. xiii + 707 pp. 1945.

This voluminous work is dedicated "to those who prefer facts to fads, sanity to superstition, understanding to belief"; hence its primary purpose is that of presenting the scientific facts related to the preservation of good health. In 700 pages, Diehl has discussed every phase of personal and public health from the standpoint of a teaching physician who is interested not only in the prevention and cure of common diseases, but also in the dissemination of knowledge concerning the maintenance of a high standard of normal, healthful living. The author's background and experience have well qualified him for the task of presenting a complete and authoritative account of such widely varied health matters as foods and nutrition, exercise, fatigue, drugs, communicable diseases, mental health, normal sex life, and modern parenthood.

The work is well documented and amply supplied with tabular and graphic material. Each chapter is concluded with a list of references and suggested readings, and a set of questions designed to stimulate discussions of the material presented. Some 150 pages of the text are devoted to appendices on Standard Weights, Nutritional Values of Foods, Health Records, and the Control of Communicable Diseases. An extensive glossary and a detailed index conclude the volume.

The third edition of this excellent text will certainly continue to find popular favor in the hands of students and teachers of public health, as well as on the reference shelves of medical schools and general practitioners.

B. AUBREY SCHNEIDER

REPORT ON THE INCIDENCE OF RICKETS IN WAR-TIME. *Reports on Public Health and Medical Subjects, No. 92. By The British Paediatric Association. His Majesty's Stationery Office, London; British Information Service, New York.* 9d.; 25 cents. 36 pp. 1944.

The present investigation was undertaken by the British Paediatric Association in an effort to determine the war-time incidence of rickets and the possibility of a need for further measures in its prevention among small children in the British Isles. Both clinical and radiological data were collected on some 5,000 children, ranging from 3 months to 18 months of age, who attended various clinics and nurseries during January and early February of 1943. In addition to the clinical examination, an x-ray of one wrist of each child was made. The x-rays were read and diagnosed by three separate radiologists without reference to the clinical diagnoses. Both the clinical and radiological data were analyzed statistically, and the findings presented in the light of such analysis.

In general, it was determined that the data thus collected and analyzed afforded no evidence of any war-time increase or decrease in the incidence of rickets in the British Isles, as compared with the few available pre-war investigations on the subject. This fact is a real tribute to the British war-time economy, which apparently was able to provide an adequate diet and proper medication for its growing children.

The report calls attention to the following problems in relation to rickets: (1) the difficulties associated with its early diagnosis, and (2) the difficulties involved in supplying the proper dietary ingredients for adequate calcification of bone in the active, growing child.

B. AUBREY SCHNEIDER

MALARIA IN THE UPPER MISSISSIPPI VALLEY 1760–1900. *Supplements to the Bulletin of the History of Medicine, No. 4. By Erwin H. Ackerknecht. The Johns Hopkins Press, Baltimore.* $2.00 (paper). viii + 142 pp.; 5 maps. 1945.

In the middle of the nineteenth century, malaria was prevalent along the entire length of the Mississippi River, but shortly thereafter there began a steady re-

treat southward of this disease, until at the present time it is practically non-existent in the upper Mississippi River Valley, and is becoming scarce in the so-called "malarious South." This virtual disappearance of malaria from the northern part of the country during the past seventy years constitutes one of the most puzzling epidemiological problems concerning this disease.

In this publication from the Johns Hopkins Institute of the History of Medicine, Ackerknecht presents the most thorough and critical analysis of this interesting problem that has yet appeared. In the first portion of the book, the author discusses the rise and fall of malaria within the five states that border the upper Mississippi River—Illinois, Missouri, Iowa, Wisconsin, and Minnesota. In the second portion, he evaluates the various factors that might possibly have contributed to the regression of malaria from the valley. This epidemiological study has entailed careful and diligent search through a tremendous number of historical records and scientific publications. It might be suspected that such a publication would contain so much factual information that it would be dry and uninteresting. The author was apparently aware of this possibility, as indicated by the following statement in his preface: "I invite the reader to use a little bit of his own imagination and not to forget the great human drama that is hidden behind the rather dry statistics and quotations which will be found in the following pages." However, there was no need of his concern, for his publication is an intensely interesting and enjoyable scientific monograph. One is constantly aware that the author's subject is "a part and parcel of one of the most fascinating episodes in human history; the conquest and settlement of the West, the great continental heart of North America."

In considering the factors that might have played a part in the disappearance of malaria within the region, the author discusses population movements, railroads, steamships, river regulations, land clearing, cultivation and drainage, prosperity, housing, screening, food, education, cattle breeding, mosquitoes, quinine climate, and weather. Several of these factors have been proposed by other writers on the subject, but never before has the actual historical and epidemiological evidence, both for and against each factor, been so thoroughly gathered together and analyzed. Ackerknecht's general conclusion is that no one factor can be singled out as the main or exclusive agent accounting for the disappearance of malaria. The arrest of population movements and the shift of settlements from the water courses inland would seem to have been of considerable importance, on the basis of statistical relationships. The organization of drainage enterprises along the Mississippi occurred too late to be of any influence. The effect of small scale local drainage is impossible to measure. There is apparently a correlation between the building of better houses and the decline of malaria, but the introduction of screening was apparently too late to be a factor. The increase in dairy cattle and the general increase in wealth of the region obviously had their influence upon the situation. Climatic conditions, although they are not too favorable in the region for malaria transmission, were nevertheless effective throughout the entire period.

The author's findings indicate that there is apparently no time correlation between the introduction of quinine and the decline of malaria. However, he believes that quinine may have had an indirect effect by making it possible for people within the region to tolerate the situation and to devote their energies to the improvement of the region. This conclusion regarding the effect of quinine is particularly interesting the light of the fact that this study was largely supported by the Cinchona Products Institute of New York. It is well to quote directly the author's stand on this subject, for it attests to his intellectual and scientific honesty. "What role did quinine play in the nineteenth century in the upper Mississippi Valley? The right answer is not to be found in assumed but non-existent specific merits of quinine. Quinine does not avoid infection; quinine does not sterilize the carrier. Quinine, therefore, cannot have a direct effect on the eradication of malaria from a community. Whoever tries to link quinine directly with the disappearance of malaria because quinine is the most direct anti-malarial measure, is pleading a lost cause, because he is pleading against the evidence. But quinine does have one quality which nobody denies and which may be decisive in certain historical situations; it stops the clinical attack; it makes people fit to fight and to work, when without quinine they would not be able to do so."

It is interesting to read the author's findings on Doctor J. Sappington, who introduced his famous "Anti-fever pills" during the early 1830's. The use of this patent medicine containing a certain amount of quinine spread all over the West. As a consequence, Sappington has been considered by some writers to be a kind of midwestern "culture hero," another Gorgas, a man with great medical insight into disease, one who championed the use of quinine treatment within the Mississippi Valley, and who was later subjected to the snobbery and jealousy of his professional colleagues of the time. Ackerknecht thoroughly debunks these assertions and comes to the final conclusion that there are four things that Sappington most certainly was not: "the promoter of quinine in the Mississippi Valley, a great doctor, a great humanitarian, or a misunderstood genius."

At the end of the book, the author does not pretend to give a complete bibliography on his subject, but simply presents an alphabetical list of the books and articles which were actually quoted in this thesis. There is no index, but a rather detailed table of contents may serve instead.

M. M. Brooke

TRICHINOSIS.

By Sylvester E. Gould. Charles C. Thomas, Springfield, Illinois. $5.00. ix + 356 pp. 1945.

With the current interest on the parasitic diseases of tropical origin, it is timely for our attention to be attracted to an indigenous parasitic disease of great importance to the United States. Although it is unlikely that trichinosis will increase as a direct result of our participation in the second World War, our interest should be sufficiently stimulated by the present data, which already indicate that from ten to twenty per cent of our population are infected with the helminth that causes the disease.

The etiological agent, the small nematode now termed *Trichinella spiralis*, was not actually observed until the third decade of the nineteenth century, but the disease apparently dates back to antiquity. It is no doubt the ability of pork to transmit this worm and so to produce explosive fatal epidemics that accounts for the old Mosaic and Mohammedan laws prohibiting the eating of swine. The encysted larval stages that resemble small sand-like particles in the muscles had been observed and recorded in anatomical studies for many years before their exact nature was determined. Here again, as with a number of important parasitological discoveries, it was a young man with a curious mind and youthful enthusiasm who undertook the obvious step of examining the sand-like particles under a microscope in 1835. James Paget, at the age of twenty-one, while a first year medical student in London, is credited with having first observed the larval stage of *Trichinella spiralis* in man. In referring to this discovery, he later wrote: "My share (in the discovery of *Trichina spiralis*) was the detection of the 'worm' in its capsule; and I may justly ascribe it to the habit of looking-out, and observing, and wishing to find new things, which I had acquired in my previous studies of botany. All the men in the dissecting room, teachers included, 'saw' the little specks in the muscles; but I believe that I alone 'looked-at' them and 'observed' them; no one trained in natural history could have failed to do so."

Anyone who has observed pork heavily infected with trichinae can easily share and appreciate Paget's enthusiasm and wonderment over their tremendous number: "Fancy the body of a single individual supporting more separately existing creatures than the whole population of the world." Although this is probably a slight exaggeration, it has been estimated that in fatal cases there may be from 50 million to 100 million encysted larvae within the individual. Fortunately, however, most individuals infected with *Trichinella spiralis* contain relatively few organisms, and only around five per cent of infected individuals show symptoms of the disease. Still, considering the amount of pork consumed, it is not comforting to know that the mortality rate is generally placed at five or six per cent and, in some epidemics, it has reached as high as thirty per cent of the individuals showing symptoms of the infection.

All phases of this important parasitic disease have been thoroughly considered in this interesting monograph of Gould's. He has driven home the point that the occurrence of the disease is an important public health problem in the United States, and, inasmuch as there is no satisfactory treatment for the disease, it must be controlled by prevention of its transmission. The scientific knowledge necessary for its prevention is known, but as yet it has not been effectively applied. In this regard, it is interesting to note that an attempt to control the disease led to our present meat inspection by the federal government, but curiously enough, meat is no longer inspected for the presence of this parasite. This odd situation dates back to the latter part of the nineteenth century, when several severe epidemics of trichinosis occurred in Germany. The Germans accused pork imported from America as the cause for the outbreaks, and passed laws prohibiting the importation of pork from this source. At that time, the Germans were already microscopically examining their pork, but this was not being done in the United States. However, as might be expected, since this restriction on American pork became a financial problem in this country, it was not long before the examination of pork was instituted by government regulations. Therefore, between the years 1891 and 1906, pork intended for export was inspected for trichinae. This method of control was later suspended, inasmuch as it was shown that such inspections did not guarantee that the meat would be free from the parasite; and due to the presence of the assuring label "U. S. inspected and passed" it tended to give the consumer a false sense of security. Furthermore, such inspections were very expensive, requiring a staff equal to the standing United States Army at that time. Although this control method is not one hundred per cent effective and is expensive, it should be pointed out that during the past seventy-five years infection with this parasite has apparently been decreasing in Germany, while it has increased in our own country. In place of meat inspection, the United States Department of Agriculture has limited its regulatory procedures to those pork products which are customarily eaten raw. For those products it insists on adequate cooking (up to 137° C.), or refrigeration (5° F.) for twenty days before the pork is placed on the market. However, due to lack of proper education on the subject many other pork products are eaten that have not been thoroughly cooked. Another important factor responsible for the spread of this disease is the practice in the United States of feeding hogs on garbage collected from the larger municipalities. It is inevitable that garbage will contain infected scraps of pork. It is to be hoped that soon laws will be passed, such as the recent one in New York

State, requiring that all garbage must be cooked before it can be fed to hogs.

Gould has performed an excellent service in collecting the present authoritative information on this disease. He has presented it in an interesting manner, and illustrated it with numerous photographs, drawings, tables, and charts. The book should be of infinite assistance to the practising physicians, public health workers, and the intelligent legislators in their efforts to alleviate the trichinosis problem within our country. It is a scholarly piece of work, possessing a subject and author index and a complete bibliography arranged chronologically from 1822 to 1944.

M. M. BROOKE

A SYMPOSIUM ON MAMMARY TUMORS IN MICE. *Publication of the American Association for the Advancement of Science No. 22.*

By Members of the Staff of the National Cancer Institute, National Institute of Health, United States Public Health Service. American Association for the Advancement of Science, Washington. $4.00. 223 pp. 1945.

As stated by Spencer in the preface, "this symposium on mammary tumors in mice has been prepared by members of the staff of the National Cancer Institute, representing various biologic specialities, who have recognized the value of what they have chosen to call the 'vertical' approach to the problem, namely, a concentration upon one particular type of cancer in one particular species." It contains the following chapters: General and Historical Introduction, by Michael B. Shimkin; Cytology of Mammary Tumors of the Mouse, by Albert J. Dalton; Morphology and Histogenesis of Mammary Tumors, by Thelma Brumfield Dunn; Histogenesis of the Mammary Gland of the Mouse, by Albert J. Dalton; The Vascular Supply of Mammary Gland Carcinomas, by Glenn H. Algire and Harold W. Chalkley; Genetics of Mammary Tumors in Mice, by Walter E. Heston; Hormones and Mammary Cancer in Mice, by Michael B. Shimkin; The Milk Influence in the Genesis of Mammary Tumors, by Howard B. Andervont; Diet and Some Other Environmental Influences in the Genesis and Growth of Mammary Tumors in Mice, by Harold P. Morris; The Chemistry of the Mammary Tumors, by Jesse P. Greenstein; Experimental Treatment of Mammary Tumors in Mice, by Helen M. Dyer; Conclusions—Including Discussion of the Possible Implications for Man, by Michael B. Shimkin. There is an extensive bibliography at the end of each chapter, and those chapters dealing with the morphology of mammary tumors contain a number of excellent illustrations. A feature that is likely to prove particularly useful is the tables summarizing the published work in specific fields. These cover such subjects as "Inbred mouse strains and their incidences of mammary tumors," "Effect of estrogens upon mammary tumor incidence in mice of various strains," and "Substances tested for their therapeutic effect on spontaneous mammary cancer of the mouse."

This book, bringing together in one volume the known facts about mammary tumors in mice, is written with the high level of thoroughness and clarity that might be expected from the group at the National Cancer Institute. Each subject is critically reviewed, conflicts of inadequacies in the evidence being pointed out and evaluated. To single out the field with which the reviewer is most familiar, Heston has presented a balanced and intelligent discussion of the genetics of mammary tumors. It is now apparent that, with the possible but not probable exception of one case studied by Bittner, the view originally held by some investigators that the occurrence of a given type of cancer is determined by a single gene is no longer tenable. This does not mean that heredity is not a factor in the origin of cancer, but merely that the genetic situation is complex.

The National Cancer Institute is to be congratulated on the preparation of a volume that will be the standard reference work on mammary cancer in mice.

GEORGE D. SNELL

NUTRITION AND GLANDS IN RELATION TO CANCER.

By F. E. Chidester. The Lee Foundation for Nutritional Research, Milwaukee. $3.00. xxii + 247 pp. 1944.

Although the title of this book suggests that it deals with the relationship of nutrition and glandular disorders to the problem of cancer, actually the author has attempted to cover almost every phase of cancer. Of the sixteen chapters, four may be classified as relating to diet and cancer and one to the endocrine glands and tumors. There is a chapter on occupational neoplasms, one on parasites, viruses and temperature, another on carcinogenic substances, and still another on the relationship of mental states to the development of cancer.

The relationship of iodine to cancer growth receives considerable attention and may be used to illustrate the author's approach. Chidester suggests that iodine can be used to advantage in the treatment of cancer, and he draws on all types of experience to illustrate the point. To select an example at random, he describes how one of his colleagues attempted unsuccessfully to secure "tumorous animals" from a general colony. "It was with great amusement that we learned from the animal keeper that he could supply no cases of tumorous animals. 'Why', said he, 'we rarely have cases of tumors in our stock, and when we do, I immediately paint them with iodine and they go away.'" (p. 42).

In general, the book is comprised of a series of unrelated, uncritical assertions and contains many misinterpreted and inaccurate statements. Examples cited as proof are often unconvincing, and the logic of presenting certain examples as evidence is not always clear.

HAROLD P. RUSCH

THE MODE OF ACTION OF SULFONAMIDES. *Review Series, Volume II, No. 1.*

By Richard J. Henry. Josiah Macy Jr. Foundation, New York. Free upon request (paper). iii+ 285 pp. 1944.

It is the purpose of this review to summarize the tremendous scope of the field of sulfonamide pharmacodynamics. The author points out that it is almost impossible for the investigator to keep informed of all published work relevant to sulfonamide action. He has therefore gathered together in one publication an extensive bibliography, with a critical evaluation of the various publications.

One of the most widely accepted theories of the mode of action of sulfonamides is that enunciated by Woods and Fildes in 1940, that a sulfonamide interferes with the utilization of the substrate para-aminobenzoic acid in an anabolic reaction by competing with PAB for the bacterial enzyme. Henry presents evidence from the literature suggesting that this theory gained rather general support because it correlates very neatly some of the major observations of sulfonamide action. However, he indicates also that several important observations made at about this same time have found no place in this theory and therefore to a great extent have been ignored. The author states that it is timely that a critical examination of the Woods and Fildes theory be made.

After reviewing in detail the evidence for and against the theory, the author draws the following interesting conclusions. While para-aminobenzoic acid has been isolated from yeast and characterized and found to antagonize sulfonamide inhibition of bacteria, this material has not been shown to act as a vitamin. PAB is regarded by the Woods-Fildes theory as an essential metabolite which is displaced from its enzyme by sulfonamide. Henry states that there has never been any direct evidence for this proposal, further that there is no consistent relationship between a sulfonamide-antagonist production by bacteria and their susceptibility to sulfonamides. The conclusion is finally reached that this theory does not offer a satisfactory explanation that is compatible with all the known facts of sulfonamide action.

It seems that a great many substances from a great diversity of sources antagonize sulfonamide inhibition of bacterial growth. Such compounds that possess this ability as glucose, urethane, methionine, and other substances of known composition cannot be classed with para-aminobenzoic acid. A large number of materials that may or may not give rise to PAB have also been discovered. These compounds as antagonists to sulfonamides may be classed roughly in three groups: group one, those which specifically interfere with sulfonamide action, such as PAB: group two, those substances which antagonize sulfonamides by non-specific growth-stimulation of bacteria,—glucose and certain amino acids appear in this category; group three, antagonists that form inactive complexes with the sulfonamide,—urethane and possibly certain proteins may act in this manner. It must be emphasized that one antagonist may fall into two or even all three categories, and of course other mechanisms are possible.

One of the most fascinating chapters in this interesting book is the one dealing with a review of the effects of sulfonamides on respiratory mechanisms. Sulfonamides inhibit the aerobic and anerobic respiration of bacteria and other cells. The identities of the inhibited enzymes that eventually cause growth-inhibition are not definitely known. Of special interest is the work that shows that sulfonamides resemble the narcotics in their character of respiratory enzyme inhibition.

The conclusion is ultimately reached that sulfonamides achieve their bacteriostatic action by direct inhibition of one or more enzymes. Of these, two types are considered, those which catalyze anabolic or catabolic processes, and those which catalyze oxidation-reduction reactions.

The theory which is most compatible with all the known facts according to the author is as follows: Sulfonamides act upon oxidation-reduction enzymes and check cell division by primary inhibition of these enzyme systems. There seems to be good reason for grouping the sulfonamides with such so-called indifferent inhibitors of respiration as the narcotics. Their action is reversible and involves a specific fraction of a total set of reactions involved in normal cell division. This is a suggestion that is reminiscent of the old lock and key theories of Paul Ehrlich's time.

One wishes that this review had been printed and bound in cloth instead of being lithoprinted and given a paper cover. Its 700 references and critical discussions make the volume a reference work of great value. The industry and perseverence of the author in the preparation of the text calls for admiration. For example, the calculations necessary to express all values for concentrations in both molarity and milligrams per cent must have been tedious, but they have added to the clarity of thought. For these the reader will be grateful.

To conclude, the reviewer is quite willing to agree with the author that there is much work yet to be done before any theory of the mode of action of sulfonamide bacteriostasis can be accepted as final.

C. JELLEFF CARR

THE RETICULO-ENDOTHELIAL SYSTEM IN SULFONAMIDE ACTIVITY. *Illinois Monographs in the Medical Sciences, Vol. V, Nos. 1–2.*

By Frank Thomas Maher. University of Illinois, Urbana. $3.00 (cloth); $2.50 (paper). 232 pp. 1944.

A description of a series of experiments designed to evaluate reticulo-endothelial activity in sulfonamide chemotherapy in experimental animals is the basis of this volume. A review of the literature and a discussion of the scope of the problem is presented in Chapter I. Certain preliminary experiments were considered desirable in order to obtain an evaluation of the importance of the reticulo-endothelial system to sulfonamide chemotherapy. These limiting experiments, together with the methods used and the results obtained, are presented in the succeeding three chapters. The results of the experiments on reticulo-endothelial blockade in sulfonamide chemotherapy are given in detail in the last chapter. The studies have considered the reticulo-endothelial system as a unit and specialized study has been made on the liver, the spleen, the lungs, the kidney, and the bone marrow. Specific studies have not been made in this investigation on the macrophages of the lymph nodes, of the omentum, or of the general distribution of the fixed tissue histiocytes or immune body formation.

The conclusion is reached that colloidal thorium dioxide may be employed experimentally to blockade the reticulo-endothelial system without toxicity to the rabbit. Animals so treated may receive sulfanilamide or sulfathiazole and be unable to conjugate these substances. Thus a chemical function in acetylating the drugs of the sulfonamide group is ascribed to the cells of the reticulo-endothelial system. During the period of acute reticulo-endothelial depression produced in rabbits by intravenous injection of Thorotrast, sulfathiazole exerts no demonstrable influence on the course and fatal termination of staphylococcic infection. Following recovery from such blockade, sulfathiazole is again effective in protecting rabbits against experimental staphylococcic infection. The author concludes that reticulo-endothelial activity is vital to the manifestation of sulfonamide chemotherapy and that any theory of the mechanism of action of these drugs must ascribe a primary and predominantly important function to this body system.

C. JELLEFF CARR

PENICILLIN AND OTHER ANTIBIOTIC AGENTS.

By Wallace E. Herrell. W. B. Saunders Company, Philadelphia and London. $5.00. xv + 348 pp. 1945.

This monograph is designed primarily to deal with the clinical application of the antibiotic agents. In addition to considering penicillin, three chapters are devoted to tyrothricin, streptothricin, and streptomycin respectively. In one section a review is presented of those antibiotic agents which at the time of writing did not possess great clinical value. The last chapter deals with antibiotic substances originating from sources other than microbes.

An interesting chapter has been written by the author on the historical aspects of the development of penicillin, a history to which he himself contributed. All the original references are given, including the 1877 publication of Pasteur and Joubert.

After summarizing the methods of preparing penicillin and its physical and chemical properties, Herrell has devoted the major portion of the text to the details of assay, *in vivo* activity, and the dosage of penicillin in those infectious diseases in which it is indicated. The color photographs of patients convey to the reader something of the sheer drama and spectacular success associated with the use of this remarkable drug.

For the teacher this volume is a valuable reference work. The clinician will find here all the minutiae he needs for the intelligent use of penicillin in the treatment of disease. Needless to say, the fundamental biological concept of the work on penicillin makes any special commendation to the biologist unnecessary.

C. JELLEFF CARR

ALLERGY, ANAPHYLAXIS AND IMMUNOTHERAPY: *Basic Principles and Practice. A Treatise presenting the fundamental principles and practice governing the use of antisera, vaccines, toxoids, blood transfusions, blood substitutes and sulfonamides, in the prevention and treatment of infectious diseases and of the allergic phenomena resulting from their use.*

By Bret Ratner. The Williams & Wilkins Company, Baltimore. $8.50. xi + 834 pp. 1943.

Ratner's presentation is divided into three books. Each contains a wealth of material. In a clear, concise manner he has presented the fundamental principles governing the use of biological products.

The author has made no attempt to give his own opinions; instead he has compiled abstracts from an extensive field of relevant literature. In the first book he presents the principles and practices of immunotherapy and discusses in detail the treatment of all diseases which respond to sera. In the second book he presents in a most satisfactory manner the allergic reactions to immunotherapeutic agents. He has not overlooked any type of reaction or serum accident. The discussion of blood transfusion, including the reactions and the accidents, should be most instructive to the student. The third book, which deals with the allergic state, is the only phase of the work which is entitled to unfavorable comment. The theoretical concepts of allergy are presented in detail; nevertheless, because of the hypothetical consideration of many of them, a student of allergy is left somewhat confused.

Because of faulty photography, many of the illustrations are poor. This indistinct illustrative material detracts from the book. Notwithstanding these two defects, the book is a valuable contribution to the science of medicine and should be most helpful to all students of immunology.

LESLIE N. GAY

ESSENTIALS OF ALLERGY.

By Leo H. Criep. Foreword by Robert A. Cooke. J. B. Lippincott Company, Philadelphia. $5.00 xv + 381 pp.; 1 plate. 1945.

Among the various branches of medicine, allergy is one of those most recently recognized. It is a field which, as yet, has been only partially explored. Much has to be learned of the fundamentals and basic principles of the allergic state, and of the mechanism involved. Furthermore, the clinical procedures which have been accepted both in diagnosis and treatment of allergic diseases are often empirical, being based largely upon the trial and error principle. It is but natural, therefore, that in its present stage of development, the subject should be confused by a great number of speculative and controversial ideas.

In spite of such obstacles, Criep has been quite successful in assembling his information in a manner which is logical, comprehensive, and yet largely free of argumentative material. The first five chapters are devoted to the broader aspects of human sensitization. The chapter upon anaphylaxis is excellent. The characteristic features of this condition are described, and their similarities and dissimilarities to the allergic state are pointed out. A reading of this terse chapter should do much to remove the confusion existing in the minds of many physicians as to the relationship of the animal and human forms of hypersensitiveness.

Experience has taught us that the diagnostic methods and therapeutic procedures of value in the various forms of clinical allergy share a pattern which must be adjusted only in some details for each type of allergic complaint. The importance of these general measures is stressed; the need for a meticulous case history, thorough physical examination, and careful testing with reliable allergenic extracts. Methods for the preparation of such extracts are described, and lists are given of those considered most necessary. General therapeutic measures are described as well as the more specific principles regarding avoidance in the environment and in the diet of the implicated allergens. The increase in the degree of tolerance to such etiologic factors achieved by injection methods is discussed in detail.

Separate chapters, each with bibliography, are devoted not only to Hay Fever, Bronchial Asthma, and Allergic Dermatoses, but to Serum, Drug, Bacterial, Fungus, and Physical Allergies. An excellent feature is the inclusion at the end of each chapter of pertinent detailed case reports. Following each case report is a discussion by the author of the important diagnostic and treatment measures involved, which he terms "teaching points." There is a chapter upon allergy in children in which emphasis is placed upon the necessity for an early diagnosis of sensitization and how this may be accomplished. A final, but most useful chapter is devoted to Diagnostic Skin Tests employed in conditions other than the clinical allergies. The technic, the manner of reading the reaction, and the interpretation, are described for the Shick, Dick, Schultz-Charlton, and Tuberculin Tests, as well as for lesser used procedures such as the Pertussis, Casoni, Foshay, Brucellergin, Malleen, Frei, and Coccidiodin tests.

In his preface, Criep states that his book is intended as a manual for the undergraduate medical student as well as for the practising physician. His crisp style, logical arrangement of facts, and ability to avoid debatable material indicate that he has been successful in achieving his purpose.

W. C. SPAIN

TRAUMA IN INTERNAL DISEASES. *With Consideration of Experimental Pathology and Medicolegal Aspects.*

By Rudolf A. Stern. Foreword by Francis Carter Wood. Grune and Stratton, New York. $6.75. xxiv + 575 pp. 1945.

The problems of internal disease caused by trauma are of great practical importance for those physicians whose work deals with accident cases coming into the courts and with cases of alleged traumatic diseases. The literature on this subject is scattered in hundreds of periodicals. The author deserves great credit for writing a comprehensive review of this subject. The practical importance of this work is emphasized by the author's statement that in this country "there are about ten million accidents a year, and many of them are allegedly the cause of ensuing internal diseases." Case reports on a great variety of diseases are discussed from every angle, including the medicolegal. The chapters on diseases of the heart and on malignant tumors are especially well documented. Statistics are often cited, but unfortunately little attention has been paid to the mathematical treatment of statistical data. An extensive bibliography and a carefully prepared index greatly enhance the usefulness of this book.

WALTER FLEISCHMANN

THE HISTORY OF SURGICAL ANESTHESIA.

By Thomas E. Keys, with an introductory essay by Chauncey D. Leake and a concluding chapter, "Th

Future of Anaesthesia," by Noel A. Gillespie. Schuman's, New York. $6.00. xxx + 191 pp.; 42 figures. 1945.

In probably greater completeness than anywhere else, the essential data on the history of surgical anesthesia from the Babylonians up to the present are listed here. As the author is a medical librarian, nobody will be surprised to find his 92 pages of text completed by 62 pages of reference and bibliographical material. Modern surgical anesthesia is now about a hundred years old (103, 101, or 99, depending on the "party" to which one adheres). It is an American accomplishment, whether one sides with Long or Wells or Morton. Under these circumstances it is most welcome to have now at our disposal this impartial and solidly documented little book, nicely printed and illustrated.

ERWIN H. ACKERKNECHT

CAESARIAN SECTION: *The History and Development of the Operation from the Earliest Times.*

By J. H. Young. Foreword by Miles H. Phillips. H. K. Lewis and Company, London. 16s. viii + 254 pp. 1944.

Caesarean section grew out of the ancient custom, still practised by primitives, of opening the body of women dying in childbirth. Its origins are not ascertainable. It seems to have been performed already by the ancient Hebrews before the Christian era. Since 1500 authentic records of the operation are to be found in increasing numbers. Mortality of mother and child was very high up to the nineteenth century, and during the first half of the nineteenth century controversy concerning the advisability and technique of Caesarean section was very widespread and passionate. Antisepsis and technical improvements, especially those introduced by Porro and Sanger, definitely established the operation, which now in the opinion of some is even resorted to too frequently.

The author has assembled the pertinent material from all historical periods up to the present time in a most thorough and intelligent manner. Though, naturally enough, his study centers around English data, American and continental attitudes and techniques are duly recorded. The sometimes atrocious misspelling of non-English names and terms is one of the few flaws of the excellent monograph. Medical men will profit greatly from the detailed reporting of the different techniques proposed, tried, adopted, or abandoned. The cultural background of the operation—the choice between Caesarean section and extraction of the child *per vias naturales*, after destruction, was strongly influenced by non-medical, religious, and philosophical motives—makes its history important beyond the limits of medical history.

ERWIN H. ACKERKNECHT

THE FALLING SICKNESS. *A History of Epilepsy from the Greeks to the Beginnings of Modern Neurology.*

By Owsei Temkin. Johns Hopkins Press, Baltimore. $4.00. xv + 380 pp.; 7 plates. 1945.

Because of its peculiar manifestations, epilepsy has been throughout history the battleground of those who followed a rationalistic approach to disease and those who were inclined toward supernaturalism. The surprisingly rational character of Hippocratic medicine becomes particularly graphic in its realistic analysis of the "sacred disease." The Middle Ages tended to a demoniac explanation of epilepsy, and more or less lumped together all kinds of convulsive disorders in the notion of the "falling sickness." Yet Owsei Temkin is able to show how the professional doctors of the period tried to preserve the scientific approach of antiquity. The Renaissance produced in a certain sense even an increase of supernaturalistic beliefs, but at least the problems were posed again, and an active fight to disprove in the concrete case the presence of the devil in the epileptic began. The sixteenth and seventeenth centuries brought new theories and new observations. The great contribution of the "enlightenment" of the eighteenth century lay in a radical break with demoniac concepts, and a thorough purging from therapeutics of all magic elements. This was the starting point for the modern scientific knowledge of epilepsy, which grew from such new methods as those of pathological anatomy, hospital observation, and statistics, and which reached its peak in the nineteenth century in J. Hughling Jackson's concept of epilepsy, and in Charcot's radical differentiation between epilepsy and hysteria. At this point Temkin's highly interesting and solid treatise ends. For a long time to come it will undoubtedly be the classic monograph on a subject which derives its particular interest from the fact that epilepsy is still one of the least solved problems of modern medicine, and represents one of the queerest alliances of psychological and bodily phenomena ever observed by medical men.

ERWIN H. ACKERKNECHT

AGEING AND DEGENERATIVE DISEASES. *Biological Symposia Volume XI.*

Edited by Robert A. Moore. The Jaques Cattell Press, Lancaster, Pa. $3.00. viii + 242 pp. 1945.

This volume contains the papers presented at a symposium in St. Louis in March 1944. The major theme was arteriosclerosis. The present state of research and clinical experience related to this basic condition in the process of aging was clearly defined and reviewed from a great variety of aspects.

W. C. Hueper, as an experimental morphologist, describes the relation between etiology and morphology in degenerative and sclerosing vascular diseases.

A number of chemical and physical agents of endogenous and exogenous origin may elicit in man and experimental animals arteriosclerotic lesions. Four fundamental types of causative mechanisms are found: changes in the vascular tonus; changes in the hydrostatic intravascular pressure; changes in the colloidal plasmatic composition caused by disturbances of plasmatic carbohydrates, lipoids, and proteins; and changes in the oxygen-carbon dioxide balance of the blood and the tissues.

Irvine H. Page concentrates on one specific phase in this big package of problems, on the part played by the lipoids in the production of arterial disease. He concludes that at least two factors can assist in producing human arteriosclerosis. One of these is lipemia. The other factor acts on the cells of the arteries themselves and is probably started by the strain of prolonged hypertension. Any method of preventing the predisposition to arteriosclerosis must, therefore, consider the prevention of hyperlipemia, the prevention of mechanical strain, and the decrease of receptivity of the tissues to plasma lipoids. So far no clear answer to these problems can be given.

William B. Kountz describes research work on degenerative diseases, conducted at the St. Louis City Infirmary. "It is only recently that even a feeble attempt has been made to study conditions of aging and degeneration. Practically no attempt has been made to study the biologic principles involved in the decline of age."

An investigation of blood cholesterol levels in elderly patients, by William B. Kountz, A. Sonnenberg, L. Hofstatter and G. Wolff, shows that in spite of the lower average blood cholesterol in men, the onset of arteriosclerosis is earlier and its incidence higher than in women. It appears that with progressive age there is a gradual lowering of the carbohydrate tolerance.

Alfred S. Schwartz and Jean V. Cooke report one of the rare cases of progeria, the weird disease in which all the symptoms of old age appear in a child (their subject was a five-year-old colored boy). This condition gives evidence that factors other than chronological age can be important in the production of senility changes. A. Kuntz surveys the effects of lesions of the autonomic ganglia, associated with age and disease, on the vascular system.

Lester R. Dragstedt gives further interesting facts to prove that arteriosclerosis is not a necessary part of the aging process, but a disease of metabolism: in 160 dogs, experimentally deprived of the pancreas, he found a high incidence of arteriosclerosis, otherwise rare in domestic dogs.

Edward J. Stieglitz shows the difficulties in the way of clinical recognition of degenerative diseases. The complex riddle of arteriosclerosis will not be solved, in his opinion, until the reasons for the variability of its distribution are explained. "Nothing would delight me more than to report upon a new, safe, informative, and practical procedure for measuring some functional reserve. Unfortunately, I cannot."

William J. Kerr challenges us by stating that if we applied what is now known concerning the syndrome of obesity, postural defects, pulmonary emphysema, and circulatory failure, we could prolong the useful life of patients with these troubles for from five to ten years.

William De B. MacNider asks for cooperative and systematic old age research in a thoughtful essay on "Age, Change and Adapted Time."

John A. Saxton, Jr. gives a fascinating summary of experiments conducted by C. M. McCay (Cornell) dealing with the relations of nutrition and prolonged life span in rats. A high-quality diet, adequate in all essentials, together with restriction of caloric intake, can increase the average life span of rats by about fifty per cent. "The potential life span of man is not known. Nutrition offers a promising approach to the problem."

J. Loeb investigates the relations between regressive old age changes and the development of cancer. He comes to the conclusion that the adaptation of the organism to its outer environment is essentially imperfect, that the process of living leads to the development of injurious substances and physical conditions ending either in the usual degenerative aging changes or in the progressive cancerous aging processes.

A round-table discussion ends this highly stimulating conference. This reader's impression might be summarized as alarmed and hopeful. Never before has our lack of knowledge of perhaps the most important pathological condition affecting man—arteriosclerosis—been more clearly expressed than by this group of outstanding scientists. The fault is certainly not theirs—their work suggests a rich and promising variety of approaches to the problem. It is the appalling lack of coordinated and well-financed research projects on old age that is to blame. "In short, of what has been done there is too much that is only almost true" (Page). But "awareness of ignorance is the prelude to learning" (Stieglitz). Especially significant, by the way, is the final discussion of these scientists. It consists almost entirely of negative answers to questions of vital importance.

Everybody interested in old-age research should carefully study these transactions, and then impress the need for greater and better research effort on others so that some action may be taken in this most vital field of medical science.

MARTIN GUMPERT

MEDICINE AND MANKIND.

By Arnold Sorsby. Watts and Co., London. 2s. 6d. xii + 116 pp.; 2 plates. 1945.

The author of this pocket-size volume tries to give an

account of the meaning and mechanism of health and disease, including a review of the history of medicine, within 106 short pages. This calls for extreme condensation of the subject matter. It is surprising that the author has achieved his goal and that he has produced a fascinating essay. Without going into details, he makes his concept of the problems of medicine perfectly clear. His approach visualizes the body in unstable physical-chemical equilibrium, constantly responding to the shifting equilibria of the outer world. An understanding both of the biological and of the social aspects of these changes is deemed necessary for further progress. According to the author, such progress is indissolubly linked with a realistic system of philosophical thought. The illustrations are very well selected to emphasize the importance both of man-made and of natural environment for human health. A short glossary of the medical and biological terms used and an index conclude this thought-provoking little book.

WALTER FLEISCHMANN

GOVERNMENT IN PUBLIC HEALTH. *Studies of the New York Academy of Medicine Committee on Medicine and the Changing Order.*

By Harry S. Mustard. The Commonwealth Fund, New York. $1.50. xvii + 219 pp.; 2 plates. 1945.

Harry S. Mustard, Director of the School of Public Health at Columbia University, has succeeded in this small volume in giving us a clear picture of the extremely complex Public Health establishment in this country. No less than forty federal agencies participate in some way in public health work. The author analyses Public Health organizations on the three essential levels: federal, state, and local. Complications and backwardness are often the result of our particular constitutional history. For reasons of space the author provides more detailed historical notes only for the U. S. Public Health Service. This second publication of the New York Academy of Medicine Committee on Medicine and the Changing Order is not intended as an exclusively descriptive study. The limitations and potentialities of public health work are therefore discussed in addition. The little book provides ready and solid information for every intelligent person on an important community problem. That the author lacks neither frankness nor a sense of humor adds to the value of the excellent treatise.

ERWIN H. ACKERKNECHT

AN INTRODUCTION TO MEDICAL SCIENCE. *Third Edition.*

By William Boyd. Lea and Febiger, Philadelphia. $3.50. 366 pp.; 1 plate. 1945.

The author of this text book states that it is designed specifically for the nurse, the laboratory technician, and the pre-medical student. One would naturally suspect that any book written to meet the needs of three such distinct groups would tend to be too general in its content to be of much value.

The book is divided into three parts. Part I: "Some General Principles" is very comprehensive in its content. The first chapter, entitled "The Living Body," is a combination of anatomy, physiology, and nutrition, with merely a superficial description of each of these subjects. In the second chapter, "The Evolution of Medical Science," the author very briefly sketches the historical background of the development of medicine. It is more or less a collection of facts pieced together to make up the chapter. The remaining six chapters in part one contain information which is pertinent, but the title of this part does not seem entirely appropriate.

Part II: "The Organs and Their Diseases" consists of fourteen chapters which deal with the diseases of various parts of the body, including the heart, lungs, pancreas, upper and lower digestive systems, and other areas. However, the chapter discussing the female reproductive system obviously does not belong here. One would expect to find this information in a textbook of gynecology. Another chapter which seems rather misplaced is the one on diseases of the bones and joints. This material is usually found in a textbook of orthopedics.

Part III of this book, entitled "Practical Applications," has only three short chapters, concerned with the prevention of disease and the principles of treatment. The last chapter is entitled "The Nurse and the Laboratory." After reading this chapter, one begins to understand what the author has in mind, but the title is rather confusing, for the nurse does not spend much time in the laboratory, and her responsibility is directly concerned with the patient. She is responsible, however, for the collections of sputum, excreta, and other materials secured from the patient and sent to the laboratory for analysis.

On the title page, it is stated that there are one hundred and twenty-five engravings and one colored plate. This information seems of little consequence on the title page, and one is doubtful of the prominence given to the colored plate. The whole book is very general in its concept, too general, in fact, to be useful as a textbook for the student nurse.

JESSIE BLACK MCVICAR

INTRODUCTION TO MEDICAL SCIENCE.

By Gulli Lindh Muller and Dorothy E. Dawes. W. B. Saunders Company, Philadelphia and London. $3.00. xii + 454 pp.; 3 plates. 1945.

This medical textbook was written primarily for stu-

dents in schools of nursing. The authors, a doctor and a nurse, who have collaborated in the writing are well qualified in their respective fields. The purpose of the book is: "To provide an overview of medical science for the young student nurse as she starts her clinical services on the ward." The whole book is methodically organized and certainly bears out the statement that "the principal aims are to acquaint the student with the causes of disease, how the diagnosis is made, the bases for treatment, preventive measures, and methods of control." The subject-matter is presented in accordance with the plan as outlined in *A Curriculum Guide for Schools of Nursing*, published by the National League of Nursing Education.

The textbook is divided into six units, each unit presenting a concise and integrated treatment of relevant material. Unit I gives a brief but interesting account of the historical development of medical science. Unit II takes up the various causes of disease and introduces the student to a general classification and definition of medical terms. Unit III discusses how disease manifests itself in the body. These chapters are clearly stated. Because of the wide range of topics, only salient factors are presented, but the material included provides general information in daily demand. Unit IV is concerned with how the doctor makes the diagnosis, and includes most of the important tests to which the patient is subjected, necessary for diagnosis and treatment. This unit emphasizes the importance of watchful nursing care. Unit V consists of a presentation of how disease is treated, including general treatment, forms of therapy, and physiotherapy. From this the student will gain an appreciation of the methods used in the prevention, alleviation, and treatment of disease, and of the nursing care required to secure optimum results. Unit VI emphasizes the preventive aspects of medicine. This is of great importance, for the nurse is not only one who gives care during illness but also a teacher of health. Federal, state, and community health programs are discussed, together with the other agencies cooperating in this effort.

At the end of each chapter there is a review to assist the student in studying the subject-matter. Further to aid the student in understanding the relationship of scientific methods in clinical medicine and nursing, some practical applications are included. Bibliographies at the end of each unit should prove helpful for reference and further study.

JESSIE BLACK MCVICAR

AN INTRODUCTION TO THE MEDICAL SCIENCES FOR MEDICAL RECORD LIBRARIANS.

By J. H. Neese and F. H. Swett. Edited by F. H. Swett. Duke University Press, Durham, North Carolina. $2.50. xi + 223 pp. 1944.

This book, prepared as a textbook for medical record librarians in training, may be regarded as another sort of medical dictionary, with the terms arranged by subjects, such as the psychosomatic system, the various organ systems, or vitamins, rather than alphabetically. This arrangement has undeniable advantages for teaching purposes. The treatment is extremely condensed, and there are no illustrations. The index is adequate.

THE JOURNAL OF PARENTERAL THERAPY. *Volume I, Number 1, Fall, 1945. Quarterly.*

Published by the Science Publications Council, New York. Underwritten by Hospital Liquids, Inc., Chicago. $1.00 per year.

PSYCHOLOGY AND ANIMAL BEHAVIOR

PSYCHOLOGY. *Principles and Applications.*

By T. L. Engle. World Book Company, Yonkers-on-Hudson, New York. $2.12. ix + 549 pp. 1945.

Engle has attempted a most difficult task. He has written an introduction to the field of psychology for students in high schools and junior colleges. Anyone who has taught the bases of psychological science to college students knows the difficulty of achieving a satisfactory balance between the sort of practical knowledge which the student wants and the kind of fundamental scientific information that is necessary to a real understanding of the practical advice. To accomplish this end with students who have had no previous scientific training, and whose desire for practical knowledge is even more naive than that of the college student, is a task whose difficulty can hardly be overestimated.

Despite all the obstacles, Engle has succeeded in doing a remarkably good job. His book lacks sound experimental support only in those areas where the evidence is so incomplete and so scattered that even the college text can do little more than present the student with the "expert's" best guess. It is true that those areas occupy a rather large proportion of Engle's book, but that fact results from the nature of the audience to which the book is directed, and from the author's announced aims.

In areas where large quantities of careful experimentation are available, Engle seems to have struck a very intelligent balance between the presentation of fundamental information and the presentation of practical advice. With very few exceptions, the student gets enough fact and theory to understand their practical applications, if only in a general way.

There has been considerable opposition among a certain group of psychologists to teaching psychology

below the college sophomore level. If students in high school and junior college can be taught the subject in the way Engle's book proposes, there seems every reason to encourage the development of more, rather than fewer, such courses.

W. C. H. PRENTICE

DEVELOPMENTAL PSYCHOLOGY. *An Introduction to the Study of Human Behavior. Second edition.*

By Florence L. Goodenough. D. Appleton-Century, New York and London. $3.75. xxii + 723 pp. 1945.

This is the second edition, brought up to date, of an introduction to the study of human behavior which was first published in 1934. Much knowledge has been added in the intervening years in the fields of psychology, psychiatry, and the related sciences, and Florence Goodenough's revision reflects this progress. But this is not the only difference between the two editions. The material, originally distributed over seventeen consecutive chapters, has been presented in a more clearly organized fashion; it has been divided into five distinctive sections: principles and methods of modern psychology; the child's equipment for living; the normal course of human development; personality deviations; the mental hygiene of development. Each of the thirty chapters is preceded by a set of questions "designed to stimulate an attitude of intelligent inquiry." Instead of the customary list of references, each topic is followed by the discussion of a basic book pertaining to the topic.

The volume is intended as a textbook for beginners on the college level. I must confess that I am envious of the students to whom psychology will be presented in such an interesting, readable, and stimulating textbook. There is nothing dry, dogmatic, or obscure about it. There is no attempt anywhere to convert the reader to any particular psychological theory or "school," nor is he confused by controversial polemics. The facts are well documented and illustrated. Wise words of caution guard the student against too rigid an application of statistics (as, for instance, on p. 488, in reference to differences between "mental masculinity and feminity").

Development is conceived as a lifelong experience, not as something which ends with childhood or adolescence. Though the early foundations occupy the bulk of the book—which is as it should be—, human development is followed through until old age. The role of motivation of normal behavior and of its deviation is explained lucidly and always with an eye on the student's own experiences and everyday observations. The reviewer is especially pleased that the author has accepted his suggestion to speak of intellectual inadequacy rather than feeblemindedness or mental deficiency when psychometric rating does not fall too far below the "average" postulated for people in our culture.

This is on the whole and in every one of its pages an excellent book, written by one who not only knows her subject well but also knows how to teach it and to present it to the student (and intelligent layman) as a fascinating orientation in a subject of interest to all. It is neither too technical nor does it try to "sell itself" through overpopularization.

LEO KANNER

IT'S A WISE PARENT.

By Mollie Stevens Smart and Russell Cook Smart, Charles Scribner's Sons, New York. $2.00. x + 206 pp. 1944.

This is an extremely readable book written by people who apparently know and like children. The authors cover the various issues of child-rearing in a light easy style that may prove deceptive to anxious parents who take up the book expecting rules a, b, and c. However, the guides for intelligent parenthood are there, in concrete form, for those who read with a sense of humor and have, besides, real feeling for youngsters.

The book considers the usual childhood problems of eating, playing, chores, money, visits to doctors, neighborhood children, manners, siblings, and even attempts a couple of tactfully written chapters on the problems of the parent. The general tenor of the authors' point of view can be summarized in a quotation taken from the chapter entitled, "Eating Can Be Fun": "After you have provided a good example, the right food, and a pleasant setting, the thing for you to do is relax and enjoy yourselves."

This book, with its cheerful illustrations, would make a good present for young parents who may take themselves and their children too seriously.

HELEN HEWITT ARTHUR

PSYCHOLOGY FOR NURSES. *Fifth Edition.*

By Maude B. Muse. W. B. Saunders Company, Philadelphia. $2.50. xx + 467 pp. 1945.

This is the fifth edition of a standard and widely used textbook designed to teach certain aspects of psychology to student nurses. The special orientation of the text toward the problems which nurses are likely to face is realistic and generally very well done. In addition, the author has included a surprisingly large amount of theoretical material. It is difficult to see why student nurses should require so much emphasis on psychological theory. On the other hand, no objection can be raised against the provision of material which exceeds the nurse's requirements.

There is only one serious objection to Maude Muse's treatment, but that one is worth some emphasis. In

revising her text, the author has apparently done very little real rewriting. The result is that the entire contents of the book have an "old" appearance. Most of the experimental references in the body of the author's discussions are to work done a great many years ago. It is true that there has been some attempt to bring the student more nearly up to date by the use of recent material in foot-notes and bibliographies, but this sort of patching hardly suffices to make an outdated approach satisfactorily modern. A great deal of valuable experimental and theoretical work which has appeared in the past fifteen years goes unmentioned. In general, it would probably have been better if the author has reduced the quantity of material in her text and had concentrated on bringing up to date those parts of the course which are of particular practical significance to the candidate for a nursing certificate.

W. C. H. PRENTICE

INTELLIGENCE AND ITS DEVIATIONS. (*Psychology Series.*)

By Mandel Sherman. The Ronald Press Company, New York. $3.75. x + 286 pp. 1945.

It is difficult to know whether authors, editors, or publishers are responsible for the recent trend toward overambitious titles on books in the field of psychology. Whoever is to blame, the matter has become rather serious from the point of view of the reviewer. Sherman's recent book is a clear case in point. Does the title legitimately describe the field which the author thinks he has covered? Or is it window-dressing? The title *Intelligence and Its Deviations* leads the reader to expect a considerably more comprehensive treatment than the book actually undertakes. There is, for example, no discussion in this book of the various techniques of test construction, except in a rather elementary and summary fashion. The discussions of specific experimental problems basic to the theoretical understanding of the concept of intelligence are also somewhat abbreviated. If these are shortcomings, the author should be criticized. If they were intentional, he should have chosen a more modest title.

On the other hand, the discussions of intelligence from the point of view of the physician are thorough and well documented. As a matter of fact, the reader quickly discovers that the book which Sherman has written is one directed toward and of primary usefulness to the medical profession. If the book is to be evaluated on that basis, and without reference to its title, it can only be considered as a very welcome and much needed survey of the facts about mental deviants from the point of view of the physician. Sherman has done a really excellent job of presenting almost all of the pertinent facts concerning the known relationships between levels of intelligence and physical, physiological, and pathological conditions. In a few places, the author has seen fit to draw conclusions which may seem premature to researchers in those fields. For the most part, however, Sherman has been extremely cautious about interpretations of experimental evidence, and the care and clarity which he has used in presenting that evidence almost always make it possible for the reader to draw his own conclusions or suspend judgment, as he sees fit.

There is a possibility that physicians and medical students who have not had specific technical training in the theory and application of mental test methods may occasionally find that the discussions in this book are not perfectly intelligible. For example, the chapter on mental growth includes discussions of Thurstone's absolute scaling method without giving the reader any understanding of the assumptions or techniques on which that method is based. There are, in addition, some confusions in the author's presentation of experimental and theoretical material. Thus, in his treatment of the experiments by Hirsch, Sherman writes, "He found that there was a decrease of I. Q.'s with an increase in chronological age, but he believed that this decline was due to environmental factors." A few sentences later, the author has written: "Furthermore, if, as Hirsch has shown, the I. Q.'s decrease with age, the conclusion that this is *not* due to the environment cannot be accepted." (Italics by the reviewer.)

Weaknesses of this sort are sufficiently few and far between, so that they do not seriously mar the total effect of the book. In general, *Intelligence and Its Deviations* is an excellent piece of work despite the fact that its broad title may frequently tempt graduate students and other readers to search it in vain for technical information about the theory and practice of intelligence testing. Essentially, this is a book on applied psychology and one of the best examples of its breed which has appeared for a long time.

W. C. H. PRENTICE

THE PSYCHOLOGY OF SEEING.

By Herman F. Brandt. The Philosophical Library, New York. $3.75. xvi + 240 pp. 1945.

Brandt's little book requires treatment by a reviewer at three different levels. In order of importance these are: *first*, the basic scientific material; *second*, the author's organization and method of presentation; and *third*, those editorial and mechanical features of the book which are presumably the responsibility of the publisher. For reasons which will become apparent, these three topics will be discussed in reverse order, leaving the most vital for the last.

To begin with the physical form of the book, one can only say that it is painfully bad. The paper is poor (perhaps unavoidably, because of war time short-

ages). The proof-reading is simply inexcusable. Some pages contain a half-dozen errors, and the book averages about one per page. The photographs are so badly reproduced as to be in some cases almost worthless. The general over-all appearance of the book is hardly what one expects from an author concerned with the applied psychology of advertising—or of vision, for that matter.

The second consideration, namely, the author's method of presenting his factual material, is also open to considerable criticism. Perhaps the most serious defect lies in the title and its implications. This book is not a Psychology of Seeing. It is, rather, a monograph which presents a very limited number of special studies concerning an equally limited aspect of the study of eye-movements, which is itself an extremely small portion of the problem of seeing. There seems to be no excuse for so misleading the potential reader. For the rest, Brandt's prose style is muddy, dull, and unclear. There is apparently no attempt to write pleasing English. His statistical treatments of data are usually unsatisfactory, for a variety of reasons which would take too much space to discuss here. In general, the author might better have omitted all quantitative material, unless he was prepared to give it in full so that the reader might check the conclusions. There are, for example, numerous cases in which the published standard error of a difference between two means does not check superficially with the means of the two distributions. To the extent that these standard errors have been affected by correlations between the two arrays, those correlations should be given. Finally, the last two or three chapters seem overly ambitious in relation to the author's past successes, and while a researcher can hardly be blamed for having high hopes, the non-professional reader is likely to overestimate the real potentialities of Brandt's experimental method.

The final and most important aspect of this little book presents a very much brighter picture. When the reader has struggled over the large obstacles put in his way by the publishers and printers and the smaller ones placed there by the author himself, he finds an extremely interesting and provocative series of experiments. Brandt's laboratory has devised an accurate technique for photographing eye-movements during the period in which a subject is reading or observing pictures. This technique enables the researchers to measure the length of time spent in fixating different portions of a page and consequently to determine quantitative relationships between the attentional values of different kinds of magazine or advertising layout. It also enables them to study certain differences between good readers and poor readers, and differences between subjects confronted with more and less "beautiful" pictures. The technique has considerable promise for the investigation of a large number of problems, although, as the previous paragraph indicated, its promise seems somewhat less than its author claims. Without quibbling about the future, however, it can certainly be said that the technique has a very solid and satisfactory present. No modern advertising man or publishing layout expert can afford to ignore the findings presented in the present work, nor can he ignore the uses of this experimental technique in attacking a large number of other applied problems.

In summary, the content of this book is extremely interesting and well worth presenting to both the scientific and the lay public. It is unfortunate that the careless method of presentation and the irresponsibility of editor and publisher will do so much to prevent the basic facts from receiving the attention they deserve.

W. C. H. PRENTICE

THE INFLUENCE OF PARENTAL ATTITUDES AND SOCIAL ENVIRONMENT ON THE PERSONALITY DEVELOPMENT OF THE ADOLESCENT BLIND.

By Vita Stein Sommers. American Foundation for the Blind, New York. $2.00. xiii + 124 pp. 1944.

This is a book presenting the author's carefully worked out academic study of a number of blind adolescents, their social and familial environments, and their emotional reactions to their total situation. Sommers begins with the hypothesis that the personality of the blind child is affected primarily by his early home experiences rather than by the fact of his handicap. In other words, he is essentially a person, and the handicap comes with him, playing a part only as it influences the emotional responses of those around him in the formative years.

After stating this not entirely original concept, the author then describes the conditions under which she has attempted to check this hypothesis. She employed three standard methods for gathering her material: 1) the standardized personality test, administered to 143 blind adolescents; 2) original questionnaires, one designed for blind children and the other for their parents, answered by 120 children and 72 adults; and 3) controlled interviews with 50 blind adolescents and their parents. One cannot fail to be impressed by the thoroughness of her research and her honesty in evaluating her results, typical samples of which are liberally sprinkled through the book.

With all this data, Sommers is able to use her last two chapters to refute Alfred Adler's theory of "organ inferiority" and to conclude that her initial hypothesis is clearly a fact. She hopes that the effect of her study will be a more general recognition that personality maladjustments in all handicapped children are symptoms especially of an unwholesome parental environment, and that this recognition will lead to more significant preventive measures on the part of those who deal with blind or handicapped children.

HELEN HEWITT ARTHUR

EXPERIMENTAL BASIS FOR NEUROTIC BEHAVIOR. *Origin and Development of Artificially Produced Disturbances of Behavior in Dogs.*

By W. Horsley Gantt. Paul B. Hoeber, Harper and Brothers, New York and London. xv + 211 pp.; 1 plate. 1944.

In this monograph, Gantt has drawn together the material of twelve years of experimentation on the production of disturbances of behavior called "neurotic" in dogs, with a brief review of the work of Pavlov and of others, pointing to the evidence for "objective psychopathology" and rather hastily passing over methods of producing the "neurosis" through natural emotional shocks, traumatic and war experiences. The book settles down to a protracted description of the artificial behavior disturbances, produced through the conditioned reflex method. These disturbances are produced through a conflict between two centers of activity, a conflict of excitatory and inhibitory reflexes, by changes in the established routine, changes of the intensity of the conditioned reflex, and by changes in the relation between the conditional and the unconditional reflexes.

The author then proceeds to describe the chronic disturbances of behavior produced artificially in three dogs. These three case histories are exceedingly important, because they describe the production of the acute behavior disturbances and their fate with various forms of "treatment," reaching over a period of 11 years in one of the dogs. The histories serve to show that the production of symptoms and their subsequent fate depend to a large extent on the innate constitution of the animal. Gantt is the first to attempt a systematic, objective description of such constitutional differences, not only in the animal reactions to the environmental situation, but in other definable physiologic terms. These three dogs were indeed quite different, varying from an essentially stable animal to a very labile animal.

Gantt describes in detail the various objective signs of induced behavior disturbance, including the muscular activity, metabolic, gastro-intestinal, respiratory, cardiac, urinary, and sexual symptoms, disturbances of the social behavior, and the tendency to generalization of the neurotic behavior. He discusses the analogies between these artificially produced states and certain psychiatric conditions among humans, namely, negativism, obsessions, stereotypy; and he compares these conditions with anxiety states. The sexual abnormalities are exceedingly interesting. There was a temporary general resolution of the dogs' tension states with release of sexual excitation.

Of all methods of treatment for the chronic disturbances of behavior, removal to a new environment and the establishment of a new emotional relationship with the animal, stressing companionship and affection, and rigidly excluding any presentation to the animal of conflicting situations, proved most potent. Even this, however, in the labile dog was insufficient to produce immunity against a return of the symptoms when the animal was returned to the working situation.

The final chapter deals with efforts to explain the psychopathological mechanisms. These are ably presented by Ischlondsky, giving the orthodox Pavlovian account; by Saul, presenting the psycho-analytic; and by Leighton, from the psychobiological, anthropological viewpoint. The individual reader may take his choice among these views. The author appears to be unable to subscribe to the strict Pavlovian or to the strict Freudian viewpoints, and his defense seems well taken.

On the whole, this monograph is devoted to setting down in detail and step by step an account of experiences which, as a matter of everyday common sense, have either been noted in their entirety or piecemeal. The value of such scientific treatment of the commonplace is not to be denied, since it furnishes the basis for the final establishment of control over these artificially produced, and conceivably of other, behavior disturbances. The author provides in advance full precautionary advice against transferring to human subjects the lessons learned in these animal experiments, and he very wisely holds himself in check in the matter of developing an overall systematization of the material. While stressing the piecemeal character of his findings, he has put down here what is perhaps to date the most inclusive formulation of the work on artificially induced behavior disturbances in recent years.

WENDELL MUNCIE

ALCOHOLICS ARE SICK PEOPLE.

By Robert V. Seliger. Alcoholism Publications, Baltimore. $2.00. xv + 80 pp. 1945.

In this little book, the author tries to drive home three facts: that the abnormal drinker is fundamentally different from other drinkers; that he should seek aid immediately; and that such aid can be found in medical science. Seliger lists 35 questions, the answers to which will determine whether one has an alcoholic problem. He describes some of the contributing factors to alcoholism, and he gives 35 common sense rules for 35 common sense re-educational guides for the abnormal drinker. He stresses throughout the point that the treatment is always of the alcoholic patient, not of alcoholism as such. This little book no doubt will have a considerable influence among a group which has been rather badly handled for the most part.

WENDELL MUNCIE

YOUR NERVES. *How to Release Emotional Tensions. By Louis E. Bisch. Wilfred Funk, New York.* $2.50. viii + 310 pp. 1945.

This is another one of those books written for the layman, and thoroughly misleading it is, as the following excerpt from the preface will indicate: "Nervousness, in whatever form, actually need not be. The average person can cure himself or herself of a case of nerves if only he or she knows how. This book—I feel confident —will accomplish just that." There are 302 pages in this book, and it would be impossible to write that much, out of any experience at all, without saying some perfectly true and sensible things. Yet there is hardly a page on which there is not some actual misstatement, or the presentation of a personal prejudice, or a presentation of the material in such a way as to make it appear that the overcoming of neurotic difficulties is relatively simple. For example, on page 67, Bisch states, "A person suffering from a neurosis cannot go insane." Also on the same page, "the psychotic does not worry, even when he is in the process of developing his symptoms, before the psychosis itself is apparent. The psychotic is too sure of his own thinking; he is not doubtful, uncertain or even confused. What's more, he does not realize he is going insane." Later on, "Worry may wear down the nerve cells, organically speaking, because when you worry an excessive and wasteful amount of nerve energy is used. Such a wear and tear over a long period may lead you to have a 'nervous breakdown,' and you may have to be put to bed for a prolonged physical rest." On page 184, "I often wonder whether women ever enjoy tobacco as much as men do. . . . I am convinced that women go to extremes in smoking more readily than men." On page 300, the author qualifies his statement in the preface as follows: "There are books galore, written in popular language, that will enable you to understand yourself better. In fact, they will enable you to cure yourself, provided your neurotic make-up is not too marked and has not produced definite tormenting symptoms. But even in the latter case there is hope. Competent psychiatrists are available who can find the cause of your difficulty and actually can turn your disturbing neurosis to your advantage."

In reading this book even in the most tolerant mood, one cannot help but feel that the cases so briefly presented are of the most minor sort of disturbances. The author introduces in numerous chapters lists of things which one should or should not do, to guard against this or that symptom. While some of this advice may rest on a general foundation of statistically sound items of mental hygiene, the unwary reader is almost certain to derive unwarranted expectations from such health hints. The book is already in the second printing and one may expect many more, no doubt, but numerous printings will not establish this as a scientifically sound volume.

WENDELL MUNCIE

MENTAL DISORDERS IN LATER LIFE. *Edited by Oscar J. Kaplan. Stanford University Press, California; Oxford University Press, London.* $5.00. vii + 436 pp. 1945.

This compilation of contributions by a number of specialists deals with the mental disorders of old age. There are seventeen different chapters by as many contributors, who set a very high standard for the whole publication. Karl Bowman furnishes an introduction which is followed by a consideration of statistical aspects of mental disorders, by Horatio M. Pollock; physiological aspects of the problem, by Nathan W. Shock; psychological aspects, by Harold E. Jones and Oscar J. Kaplan; sociological aspects, by H. W. Dunham; mental health and nutrition, by L. Erwin Wexberg; neuroses, by Norman Cameron; involutional psychoses, by Eugene Davidoff; pre-senile dementias, by George A. Jervis; senile and arteriosclerotic psychoses, by David Rothschild; toxic delirious reactions, by Wilse Robinson; effects of long hospitalization, by Eugenia Hanfmann; the subnormal, by Oscar J. Kaplan; psychosomatic problems, by Bela Mittlemann; psychotherapy, by Fred Rockwell; mental hygiene, by Nolan Lewis; and general orientation, by Edward Stieglitz.

This volume reflects a growing problem: the welfare of the older segment of our society. It is not too much to hope that out of such interest there will develop an attitude toward the aged and their problems which not only will be more humane than some of the current attitudes but will promote the best use of the residual assets of this group. This is a very worthwhile volume.

WENDELL MUNCIE

TOTAL WAR AND THE HUMAN MIND. *A Psychologist's Experiences in Occupied Holland. By Major A. M. Meerloo. International Universities Press, New York.* $1.75. 78 pp. 1945.

This little book, the result of two years' experiences in Holland during the German occupation, is an attempt to portray the effects on the individual and on his society of military suppression and of the growth of underground activities, the consequence of man's eternal longings for freedom. While there is nothing in this little book which has not been elsewhere reported, it is a very moving statement of the psychology of suppressed peoples. Meerloo states that there are three fundamentals for any reconstruction of a more rational world; the internationalization of war strategy, a process which could eventually became the basis of an internal police force; the operation of an international statute dealing with the fundamental rights of human beings; and the organization of an actively democratic education.

WENDELL MUNCIE

THE SHAPING OF PSYCHIATRY BY WAR.

By John Rawlings Rees. W. W. Norton and Company, New York. $2.50. 158 pp. 1945.

This book, the latest in the series of Salmon lectures, presents an exceedingly interesting account of war psychiatry as practised in the British Army by the Consultant Psychiatrist to the British Army and Medical Director of the Tavistock Clinic. The book is divided into four parts: "The Frontiers Extend," "Opportunities Emerge," "The Way Ahead," and "The Tasks of Psychiatry." Rees describes the growth of the British system of selecting recruits, draftees, and officer candidates, and compares the British experience with the American. One may suspect that despite the relatively wide use of psychiatrists covering all inductions in the United States, the British with their limited psychiatric personnel will be found to have done perhaps as good a job at weeding out the unfit, and perhaps a better job in placing square pegs in square holes. Particularly valuable is the author's description of the British method for acquainting young psychiatrists with army life as commonly thought of by the line officer. His emphasis on the use of trained psychologists and of enlisted personnel with psychological training is in line with the experience of the American Army. The very practical methods used by a mixed selection board, composed of psychiatrists, psychologists, and line officers for the determination of officer candidate fitness would seem to be the epitome of practicality. The psychiatrist as a general adviser to executive officers of large units on problems of morale, personnel fitness, and administration proved most helpful. These experiences and many others Rees suggests will find useful continuation in civilian life, particularly in industrial medicine.

A brief statement concerning women's services in the army brings out the interesting phenomenon that, whereas men in the army habitually fear impotency as a consequence of the fear of loss of initiative related to the rigid discipline, the women of the Auxiliary Territorial Service exhibited a fear of sterility. This was noted, for example, in those girls who were operating radio detection apparatus. It was found best to combat this fear not by categorical and scientific denial, but indirectly by relating instances of women in the service who had lately had babies.

A kind of group psychology was practised in the form of discussion groups, in which anything that the group wanted to bring up could be thoroughly aired. Rees notes that prisoners of war present a very special problem, and he feels that these men will offer most serious difficulties in rehabilitation. Every effort has to be made to make the ex-prisoners feel that the people about them care for them as individuals and that they are necessary to the group surrounding them. The author's impression is that the neurotic casualties of battle were on the whole best treated in a completely military environment rather than in a mixed civilian and military environment, except in very special instances. He also notes that for therapeutic purposes, ordinary sedation, pentothal, and hypnosis all give comparable results.

Rees looks to the future of psychiatry in Great Britain as developing along the lines of preventive medicine, rather than in terms of treatment of people who have already broken down. He sounds a very sober note in concluding that the therapeutics of this war have not provided anything very startling, and implies that psychiatry in this war has progressed along the lines of mental hygiene rather than psychotherapeusis. The book is eminently readable and must be classed as one of the better texts covering in summary fashion the major aspects of the psychiatric contributions of World War Two.

WENDELL MUNCIE

HUMAN BIOLOGY

MODERN MAN IS OBSOLETE.

By Norman Cousins. The Viking Press, New York. $1.00. 59 pp. 1945.

Evolution, progress, and science have brought man to the Atomic Age. Soberly yet hopefully, this brief essay, an expansion of a widely publicized editorial in the Saturday Review of Literature that appeared soon after the atomic bomb fell on Hiroshima, considers the fateful question: Is war inevitable because it is in the nature of man?

Only men and ants really practise warfare, as distinguished from individual combat and hunting for food. But there is ample ground for believing, as Julian Huxley has pointed out, that war is not inherent in human nature, but is only an "expression of human nature," a result of our vicious competitive struggles. Now the end looms imminently and ominously before us—the "complete obliteration of the human species." There is nothing in evolution to assure us that this cannot happen—quite the contrary. Modern man is obsolete because he is a "self-made anachronism," because he has "exalted change in everything but himself." Now both biology and will are necessary to avoid destruction. Has man the biological capacity to rise to the occasion? There is room for hope in this respect, for there is no more adaptable animal than man in all of nature. But will he manifest the will to change? Can he curb, in other words, his own "savagely competitive impulses?" There is also hope here, for anthropologists regard man as fundamentally a social, gregarious creature.

The argument continues with a thoughtful consideration of the adjustments that will be necessary, particularly in education and in the "transformation . . . from national man to world man." The experience of

ancient Greece and that of the founding of the United States are drawn on for enlightenment. The conclusion rests in three basic principles:

"No control without power.
No power without law.
No law without government."

World government is thus one solution—the only other is deliberately to eradicate all civilization and to return to complete savagery, to the ways of life of 10,000 B. C.

The essay is supplemented by a number of eloquent and appropriate quotations, and has an appendix containing portions of two of the most pertinent papers from *The Federalist.*

The hour spent reading this little book may well be as profitable as any in a man's life.

BENTLEY GLASS

THE PSYCHOLOGICAL FRONTIERS OF SOCIETY. *By Abram Kardiner with the collaboration of Ralph Linton, Cora Du Bois, and James West. Columbia University Press, New York.* $5.00. xxiv + 475 pp. 1945.

The author here "undertakes to describe a technique for studying the reciprocal relations between culture and personality, and to furnish a reliable critique of cultural forms." This effort rests on the description of the "basic personality" of a given culture, defined as "that personality configuration which is shared by the bulk of the society's members as a result of the early experiences which they have in common." It does not correspond to the total personality of the individual but rather to the projective systems, or ". . . the value attitude systems which are basic to the individuals' personality configuration."

The concept of the basic personality, as developed by Kardiner and Linton in a previous publication, rests on certain postulates: "1) that the individual's early experiences exert a lasting effect upon his personality, especially upon the development of his projective system; 2) that similar experiences will tend to produce similar personality configurations in the individuals who are subjected to them; 3) that the techniques which the members of any society employ in the care and rearing of children are culturally patterned and will tend to be similar, although never identical, for various families within the society; and 4) that the culturally patterned techniques for the care and rearing of children differ from one society to another. Assuming the correctness of these postulates—it follows: "1) that the members of any given society will have many elements of early experience in common; 2) that as a result of this they will have many elements of personality in common; and 3) that since the early experience of individuals differs from one society to another, the personality norms for various societies will also differ."

In this book, Kardiner has taken the ethnographic descriptions of three disparate cultures, the Comanche, the Alorese, and that of a mid-western rural village, Plainville, U. S. A., and has subjected these descriptive facts to a searching psychological analysis. This follows Freudian psychodynamic lines, with special emphasis on the factors influencing child growth and character development, the parent-child relationships, the sources of anxiety, and the means for its alleviation in reality and in fantasy projection. The origins of the varying cultures can only be surmised as related to subsistence factors. In Comanche and in Tanala society (the latter published earlier and discussed briefly here), revolutionary changes in the culture, introduced by economic or other factors, made for the disruption or preservation of the culture by way of their effect on the basic personality. For example, the introduction of increased mobility (through the horse) and of action at a distance (through firearms) revolutionized Plains culture, and from this, through the exploitation of aggression, Comanche culture blossomed.

Ethnographic description is bolstered by detailed personality analyses of individuals of each society, giving at once a glimpse of the basic personality in various guises and of its range of variation. Rohrschach tests of Alorese subjects, read blindly by Oberholzer, are reported to have offered fundamental validation of the psychological profiles otherwise determined.

The dreams, folk tales, tribal customs, and religious beliefs and rites, especially in the "primitive" cultures of the Comanche and the Alorese, were most valuable as projective screens for the basic attitudes and values of the culture. Reciprocally, religious beliefs and tribal customs played determining roles in forming the character of every member of the culture. The primitive cultures are seen as more "static," and in some there is a high degree of stability through the easy access to some mechanism for the release of anxieties. As contrasting cultures, it would be hard to imagine two more different than the Comanche, with its freedom from restraint and incentive to aggression, and the Alorese, with its omnipresent frustration and resulting loss of initiative and suppressed hostility.

The description of the basic personality of the culture of Plainville, U. S. A., is more difficult because more complex. Yet this reviewer was carried back to his own mid-western early life—nostalgically, from an appreciation of its essential accuracy.

In the last chapter, Kardiner attempts to correlate wide arcs of history with the basic personality. Does the latter change as revolutionary forces of history are brought into play? Only in western civilization is there a long recorded history. The author explores the religious systems (a major projective system for the alleviation of anxiety) over the 4,000 years from

the Hebrew Prophets to Calvinism. His conclusion is that basic personality did not alter, but that the religious systems altered in reaction to new adaptational demands of a political, economic, and scientific sort. He concludes that our present extremely explosive state rests on the breakdown of older anxiety-relief mechanisms, and the failure to develop adequate new ones. In this effort, the state has largely supplanted formal religion and is now failing in its turn, largely through the effect of science on man's grasp and control of reality values.

This is a most provocative chapter, and the author makes out a good case for the utilization of the basic personality concept for the elucidation of history, in the latest effort to "edit history," following on the Darwinian and the Marxian efforts. The concept of basic personality as a tool for historical interpretation disposes of the idea of a uniform and constant "human nature." It further reduces to the barest minimum, if not to zero, the idiosyncratic features termed "constitutional" and often in the past thought to rest on anatomical (or racial) differences. It can be shown that internal adaptive controls for the adjustment of tensions are more effective than are external controls. Variations in the basic personality in different societies determine different methods influencing the relations between units of those societies, and so point to factors making for cohesiveness, solidarity, anxiety, stability, etc.

This is a most important application of dynamic psychology to the facts of social anthropology. It furnishes abundant proof of the value of the concept of basic personality, and of its usefulness in the interpretation of varying cultures, and of the facts of history in any one culture. Kardiner has done a magnificent job of integrating two disciplines, and his efforts are all the more praiseworthy since he received help and encouragement only from the other discipline, and not from the workers in his own. This fact is hard to understand unless one concludes that the psychiatrists in his bailiwick are completely sectarian, and narrowly so. It would seem to me that such an integration of psychology and anthropology would enrich the former certainly as much as the latter. As an exercise in intellectual pioneering, this book offers a thrilling experience, provocative, challenging to set conceptions, and satisfying in its contribution to human understanding. The number of psychiatrists who will buy and read this book ought to offer some solace to the author for the isolation meted out to him in its preparation.

WENDELL MUNCIE

THE SOCIAL SYSTEMS OF AMERICAN ETHNIC GROUPS. *Yankee City Series, Volume III.*

By W. Lloyd Warner and Leo Srole. Yale University Press, New Haven. $4.00. xii + 318 pp. 1945.

This is the third volume of the six-volume "Yankee City" series, published under the direction of the anthropologist W. Lloyd Warner. It deals with the fate of eight ethnic groups (Irish, French Canadians, Jews, Italians, Armenians, Greeks, Poles, and Russians) in "Yankee City," a small New England town of 15,000, as reflected in the changes of these groups' residence, economic, and class status. Particular attention is paid to the role that family, church, school, and other associations play in the process of assimilation. The authors conclude: "Paradoxically, the force of American equalitarianism, which attempts to make all men American and alike, and the force of our class order, which creates differences among ethnic peoples, have combined to dissolve our ethnic groups. Until now these same forces have not been successful in solving the problem of race. . . . The future of American ethnic groups seems to be limited; it is likely that they will be quickly absorbed. When this happens one of the great epochs of American history will have ended and another, that of race, will begin."

Among the numberless treatises on the progress of the immigrant pilgrim, this one is outstanding for very successful use of strict scientific methods. Quantitative approaches and specified observations do not obscure or desiccate, but rather illuminate a lively picture of social reality. Though the book makes part of a series, and consultation of the chapters on ethnic groups in the foregoing volumes yields additional information, it can be perused with profit independently. Its study will provide, along with deeper insight into the process of Americanization, the much needed sympathetic understanding for the individual actors of this human drama.

ERWIN H. ACKERKNECHT

FUNDAMENTALS OF SOCIAL CALAMITY. *Three Interdependent Articles of an Advanced Ecological Nature.*

By Paul Douglas Abrams. Witkower's, 77 Asylum Street, Hartford, Connecticut. $2.00. 74 pp. 1945.

The author of this work seems to have but little confidence in the intelligence of the average man, and much of it he wrote through his hat, apparently to make it appeal to those whose I. Q. is in the lower brackets. The result is a strange mixture of erudite wisdom and egregious piffle.

To the author, the war in which the civilized world has been so successful in embroiling itself is not so much a disease as the symptom of a diseased condition, other symptoms of which are the increasing death rates from all causes, such as preventable diseases, avoidable accidents, etc.; the pollution of our beaches with various kinds of garbage, the tin can dumps with which we decorate our landscapes; and the raw sewage

which we discharge into our water courses. These things were not born of the war. They have always been with us.

The human race has always habitually fouled its own nest. It carries within itself the seeds of its ultimate destruction, and only a drastic operation can save it from an early death by its own hand. There is of course nothing peculiarly original in this diagnostication of the ills that beset modern civilization, but there is in the suggested remedy. The author calls for a recasting of the entire educational system, and the most interesting part of the book is the author's description of the University of the future which will dispense the type of education which he considers essential.

The author has no faith in political panaceas—lasting reformations cannot be imposed from without. The only hope for the future lies in reforming the individual within—with the psalmist he cries, "Renew a right spirit within me," a spirit of determination that corruption in high places must be resisted and abuses of privilege must cease. Unfortunately the author calls this a spirit of Determinism—an unfortunate choice of terminology, for since time immemorial this term has been used to designate the mechanistic philosophy of despair which holds that all the universe, and human personality as well, is like the law of the Medes and Persians that "Altereth not."

This lesson which the author seeks to inculcate in his readers is the same as that in Ibsen's play *An Enemy of the People*. A man is never so strong as when he stands alone. Organization on behalf of any cause conduces to mob action, and mob action is always to be deprecated, whether it be committed by the Communist, the Free Thinker, the Catholic, the Protestant, the Nazi, the Fascist, the Democrat, or the Republican. The actuating motive of all mob action is to do away with the enemies of the mob, but according to the author this can be accomplished only by adopting the same methods of repressive violence for which they are condemned. It is the old story of Amaziah and the Children of Seir over again.

Further, according to the author, the Pacifists also constitute a mob, for they in turn have their enemies which they would like to do away with, but the reviewer feels that there is an important distinction to be drawn here that the author has overlooked. The mob seeks to do away with its enemies by destroying them, while the pacifist does away with his enemies by making friends of them—a more practical means.

The reviewer feels that this attempt to interpret the work under discussion is very inadequate and incomplete. But perhaps for that very reason it is the more appropriate, for the impression given by the book is one of inadequacy and incompleteness, and the absence of an index confirms the impression.

THE PET SHOP. *A Play.*

By Gustav Eckstein. Harper and Brothers, New York and London. $2.00. 196 pp. 1944.

Using the transparent disguises of the animals in a pet shop, Gustav Eckstein has presented the big and little nations of the world, breeding, laboring, singing, or quarreling for a bigger share of the crowded space. All was relatively peaceful in the pet shop, under the aegis of the Bird of Paradise, until the crazy Nazi monkey set the big animals to fighting as of yore. They wreck the lives of the little ones, and the Bird of Paradise dies. Eventually the monkey is caged, and the small turtle, his ally, likewise. The mice, the guinea pigs, and the canaries pick themselves up from the ruins and commence anew to mine, to breed, or to sing. The shopkeeper returns, and we learn that there will be a new Bird of Paradise to replace the dead one.

The comment on human ways is often keen and biting. Witness the monkey's speech: "A special kind of blood flows in Monkey's veins! Monkey blood! Cat—? Cat blood! Big Turtle—? Cold blood! Dog—? Mixed blood! Only Monkey has Monkey blood! (*Repeats with great solemnity.*) Monkey blood! Monkey blood! Monkey blood! (*Exploding.*) But do I have my rights?" Two questions arise, however, that one would like to ask the author. Where, in so transparent an allegory, is the United States? There is a Panda for Russia, a Dog for Britain, a Cat for France, a Big Turtle for China and a Little Turtle for Japan, but no animal for America. No one, that is, unless the patient, kindly, and impartial shopkeeper—the Man—but that is much too arrogant a thought. The Man must be the ideal of all peoples, as yet unrealized by any. But then where is the United States? Or is this not One World after all?

The second question is the troublesome one that grows from the incessant activities of the guinea pigs. Is it not clear that they will very soon, barring the wars of the Big Animals, over-populate the shop and crowd out even the mice and the canaries? If it is true for the Big Animals that "No one has the right to grow as big as he can grow," what about the mathematics of breeding on which the guinea pigs concentrate?

Possibly this play will never see the stage, but it is thought-provoking and deserves a wide circulation. Biologists will find that it voices many of their unspoken views about human affairs.

BENTLEY GLASS

PREHISTORIC CAVE PAINTINGS. *The Bollingen Series IV.*

By Max Raphael. Translation by Norbert Guterman. Pantheon Books, New York. $7.50. 100 pp. 1945.

Opening this volume, biologists will first be attracted to the 48 plates that reproduce Aurignacian and Magdalenian cave paintings, chiefly from Niaux, Castillo, Pindal, Covalanas, Les Combarelles, Font-de-Gaume, and Altamira. These are taken from the drawings of the Abbé Breuil and his collaborators. They are printed on beautiful Italian laid paper—something of a wartime mystery. Although lacking color, they represent most faithfully the studies of the great authority on Paleolithic art. Why is it, nevertheless, that we must still depend wholly on drawings, however excellent, for our knowledge of these oldest human works of art? Is it not time for an adequate photographic study that would at least offer a confirmation of the details of the drawings? While, if too much of the Abbé Breuil has crept into the drawings, the entire edifice of reasoning, archeological and aesthetic, based upon them, may be unsound.

As to the drawings themselves, they can only excite real wonder. The marvelous naturalism with which these herds and processions of mammoths, bison, oxen, horses, and reindeer, and the occasional bears, lions, and hinds are drawn in profile; the lack of human figures, save for grotesque cyclopean monsters, weird sorcerers, and "anthropoid" figures engaged in fertility rites; and the magic signs and symbols strewn over the pictures continually excite our admiration or curiosity. A study of the drawings indicates not only that, contrary to certain contentions, the Paleolithic artists could draw groups as well as single figures; but also that, although most of the animals are standing still, some are portrayed in vigorous motion (e.g., the rearing horse of Les Combarelles, the galloping red horse and the charging boar of Altamira); and that in drawing the far and near sides of the animals and in showing the roundness of the bodies, the artists were not ignorant of contours and perspective. The verisimilitude of the best of these drawings is the more astonishing when we realize that a comparable ability to draw was not reattained, to our knowledge, in any civilization for thousands of years,—in Europe hardly before the time of the Renaissance.

And so to the text—Max Raphael, erstwhile German critic and scholar, is learned and to a certain degree convincing. With his main point—that these drawings are in no real sense "primitive"—there can only be hearty assent. That they are based partly on magic rites connected with hunting, partly on totemism, is only too probable. That the "lying" figures, chiefly of bison, are in reality seated, in propitiatory rites for the dead spirit of the slain animal, is also an idea the anthropologist will find familiar. The magic of the eye and the magic of the hand can hardly be doubted, either. To go farther, as Max Raphael does, and to attribute virtually all body proportions and spacing of animals in groups to the proportions of the hand and the ratio of the unevenly divisible fingers, and to derive the artist's "golden section," 2:3=3:5, makes an interesting series of conjectures; but is it sound? Much of the author's reasoning is on this level. There is far too much of a tendency to elevate his subject to a level of grandeur: "Here, in the paleolithic age, we have not only the first conception of the *Liebestod*, but the first idea of catharsis, and the germ of the chorus . . . both morally and politically, paleolithic ideology reaches universal human dimensions, and some of the scenes have the grandeur of Aeschylian tragedies." Are these more than empty words?

At his worst, the author soars into ponderous phrases that leave one gasping and bewildered: "The mural paintings of the paleolithic caves reveal . . . aesthetic feelings. . . . The strongest is the feeling of the greatness, the power and the dignity of Being. This is not an infatuation with any concrete forms of existence but a kind of adoration, a sacred devotion to Being, pure and simple; not for a being that has transcended the phenomenal world, but for the Being that has divested itself of all mere relationships and yet includes the individual—not as an accident but as an essence; for Being that does not transcend the world but *is* in its constancy. . . . Whether Being was conceived as inert or as subject to an impersonal, nonvitalist force, these artists achieve the same objectivity, the same freedom from purely subjective elements, and even from human consciousness. Paleolithic art displays the first great wonderment before the miracle of pure Being that mankind was not able to translate into concepts before Parmenides." If the thought of the Paleolithic artists embraced one-tenth of the philosophical abstractions and aesthetic emotions Max Raphael attributes to them, one can understand why Cro-Magnon skulls are larger in brain capacity than those of modern European man. It is to be feared, however, that the art critic has forgotten the profound influence of the culture pattern in molding and limiting the range of human thought.

BENTLEY GLASS

THE EXCAVATION OF LOS MUERTOS AND NEIGHBORING RUINS IN THE SALT RIVER VALLEY, SOUTHERN ARIZONA. *Papers of the Peabody Museum of American Archaeology and Ethnology, Harvard University, Vol. XXIV, Number 1.*

By Emil W. Haury. Peabody Museum of American Archaeology and Ethnology, Cambridge, Mass. $4.50 (paper). xvi + 223 pp.; 30 plates. 1945.

This report is based on the materials gathered by the Hemenway expedition to the Southwest in 1887–1888. Little has been published on the results of this important and extensive expedition, and some of the "facts" published were very misleading. Recent work in the Southwest has developed sufficient knowledge of the cultures of the Salt River valley of Arizona, where the major excavations of the expedition were

carried out, to make reexamination of the materials profitable. This work Emil W. Haury has now carried out.

The materials belong primarily to the late pre-Columbian periods of the archeologic record. They illustrate especially the condition of the Hohokam culture at the time when the Salado peoples, a puebloan people from the north, lived among the Hohokam.

The material is discussed methodically. Pottery and its designs, textiles and their weaves, shells and their places of origin, utilization, and so on, are carefully analyzed. All traits are discussed as to their relation to the known cultures of the area. Particularly important is the publication of the expedition's sketch maps of the very extensive ruins that have since been obliterated.

This careful and thorough job by one of the outstanding men in this field is a most useful and commendable piece of work.

GEORGE F. CARTER

ARCHAEOLOGICAL STUDIES IN NORTHEAST ARIZONA. *A Report on the Archaeological Work of the Rainbow Bridge—Monument Valley Expedition. University of California Publications in American Archaeology and Ethnology, Volume 44, No. 1.*

By Ralph L. Beals, George W. Brainerd, and Watson Smith, with appendices by John T. Hack and Volney H. Jones. University of California Press, Berkeley and Los Angeles. $5.00 (cloth); $4.00 (paper). xii + 235 pp.; 1 map. 1945.

The Rainbow Bridge-Monument Valley Expeditions organized by Ansel F. Hall and carried on from 1933 through 1938 amassed a large amount of scientific information. The archeological results are presented in this report.

The methods of work are given, and the excavated sites are described in detail. The principal discussion revolves around the establishment of the cultural chronology by an analysis of pottery design. The high degree of expertness that the Southwestern archeologists have developed in the use of design analysis is well exemplified here.

There are three appendices: John T. Hack states the sequence of events in the recent geology of the Tsegi Canyon, where much of the archeological work was done; Volney H. Jones gives the pertinent data on the plant materials recovered from the excavations; the third appendix discusses the statistical methods used in the determination of the pottery chronology.

GEORGE F. CARTER

PRE-INCAIC HUAMACHUCO. *Survey and Excavations in the Region of Huamachuco and Cajabamba. University of California Publications in American Archaeology and Ethnology, Volume 39, No. 4.*

By Theodore D. McCown. University of California Press, Berkeley and Los Angeles. $2.00 (paper). x + pp. 223–399; 1 table; 7 maps. 1945.

This is a technical archeological report on a survey and some limited excavations carried out in the Huamachuco and Cajabamba regions of Peru. The principal interest centers about some large ruins. An attempt is made to place these in their correct cultural niche. Much use is made of the historic accounts of the area and of the surviving accounts of Incaic history.

ETHNOLOGY OF THE WESTERN MIXE. *University of California Publications in American Archaeology and Ethnology, Volume 42, No. 1.*

By Ralph L. Beals. University of California Press, Berkeley and Los Angeles. $2.25 (paper). 176 pp. 1945.

The Mixe live in the rainy and inaccessible mountains of the Isthmus of Tehuantepec in the Mexican State of Oaxaca. Even these shy and isolated mountain dwellers have been subject to considerable "acculturation" since the time of the Spanish conquest. The author has studied with particular care the fundamental structures of Mixe society: their town government and catholic rites. He was able to collect a considerable body of information on surviving, secret, non-Christian rituals, which in the more conservative villages equal in importance the Christian ones. Around these facts a great amount of valuable data on food quest, material culture, family life of the Mixe, etc., is grouped. The lively and excellent presentation of an interesting subject elevates Beals' study far above the average of ethnographic monographs.

ERWIN H. ACKERKNECHT

MAN'S MOST DANGEROUS MYTH: *The Fallacy of Race. Second Edition.*

By M. F. Ashley Montagu. Foreword by Aldous Huxley. Columbia University Press, New York. $3.25. xiv + 304 pp. 1945.

To this second edition four new chapters and three appendixes have been added. The former are: Race and Blood; Myths Relating to the Physical Characters of the American Negro; Are the Jews a Race?; and What Is the Solution? The appendixes deal with: The Springfield Community-School Plan in Education for Democracy and Cooperation; An Educational Exhibit Dealing with the Races of Mankind; A Film Strip on Race.

All that was said of this book in the review of the original edition (QRB 18: 172. 1943) is still applicable. This is a clear, thought-provoking discussion of the

question of the existence of races in man and of the problem of racial prejudices.

One point should be clearly understood from the beginning by every reader. The author is not denying the existence of human ethnic groups which would fit the genetic definition of a geographic race. He is careful throughout the book to make it clear that it is the older anthropological conception of "race" that he regards as utterly fallacious and pernicious. Everywhere he uses the term "race" in quotation marks, everywhere, that is, except in the title of the book—a most unfortunate omission, since it may well lead to initial misapprehension on the part of many readers.

The author makes no pretense of examining the evidence fully and critically in this volume. The content is polemic and argumentative rather than characteristic of a scientific treatise. Montagu is also unnecessarily repetitious. But against both these criticisms he would perhaps justify himself by pointing out the character of the audience for which the book has been written. As to fact and opinion, there is very little indeed in the volume with which I for one would take issue. The book deserves a continued wide circulation.

BENTLEY GLASS

POPULATION ROADS TO PEACE OR WAR.

By Guy Irving Burch and Elmer Pendell. Foreword and Postscript by Walter B. Pitkin. Population Reference Bureau, Washington. $2.00 (cloth); $1.00 (paper). v + 138 pp. 1945.

This brief discussion of population problems is of uneven merit. It is perhaps likely to exert a wide but unfortunate influence, for it is well written and interesting in style, while it is loose and uncritical in analysis and opinion. Of unfounded opinion and even bias there seems to be a considerable amount.

The book first considers the dependence of freedom from want, of democracy, and of freedom from war upon population limitation. The relations of the problem of population control to such psychiatric aspects as the sex urge, the survival urge, and the reproductive urge are pointed out, and the merit of birth control as a means of obviating the difficulties is stressed. Next the effects of migrations on population densities and control are considered, and found in the end to be unimportant. Sterilization is urged as a useful and helpful measure to supplement other measures of contraception, as well as for eugenic reasons. Here it is far too blandly assumed that there will be a considerable genetic effect, but the ultimate argument for it is placed, as it should be, on the undesirability of parenthood for criminals or mental defectives simply because they cannot be good parents, because they cannot provide the social environment to which each child has a right. The arguments for legal marriage qualifications, under the headings of age, economic status, health, and education are very debatable, but with at least some of them one can agree.

As a popular discussion of population problems, this book ranks far below Warren Thompson's book, *Plenty of People*.

BENTLEY GLASS

BIOMETRY

VITAL STATISTICS AND PUBLIC HEALTH WORK IN THE TROPICS.

By P. Granville Edge. Foreword by Major Greenwood. William Wood, Williams & Wilkins Company, Baltimore. $5.00. xii + 188 pp. 1944.

It is somewhat of a surprise to thumb through a book entitled Vital Statistics and find that it contains virtually no numerical data and literally no tables. The book starts, in fact, with a recognition of the serious inadequacy of the human book-keeping in the tropical countries governed by Great Britain, and proceeds with the two-fold purpose of establishing the importance of ascertaining the facts and of considering methods of securing them. In his foreword, Greenwood reminds the British public that "there are colonial territories administered by us for generations the vital book-keeping of which is far cruder than that of the home country three hundred years ago."

Major Edge, who writes from a background of experience in the tropical colonies of Great Britain, stresses the importance of having reasonably accurate information on population number and composition, on the number of births and deaths occurring, and on the number of illnesses, at least in the major categories. He discusses the dangers of attempting public health programs in any responsible way when only guesses as to these facts serve as a guide. In his treatment he indicates specifically what items of information are necessary as bare essentials and presents a simplified disease nomenclature suitable for the tropical areas.

After developing the necessity of getting the facts, Major Edge enlarges on the ways and means of accomplishing this. Discussing the peculiar difficulties associated with religious customs and beliefs, local medical practice, superstition, family conventions and the like, he shows the futility of relying on the usual European methods of census-taking and registration to secure the information. The belief that it is inviting misfortune to mention the eldest surviving child, that a particular number may not be spoken without ill-luck, and countless other associations and practices in the local areas must be thoroughly known and taken into account in eliciting information. The author discusses several possible procedures for getting estimates of the facts, most of which have been tried and

found useful, either as a supplement to or as a replacement of more orthodox methods.

The final chapter on the importance of carefully assembled facts as a prerequisite to post-war reconstruction is of especial interest at the present time. Major Edge comments on the past indifference characteristic of Great Britain with regard to her colonial possessions, and predicts that after the shock of the war in all parts of the world, there will be no return to "normal conditions." He expects that "indigenous peoples will demand, and will be given, a greater measure of self-government within the boundaries of their territories. This means that new conceptions of Empire will have to be found and the difficult problems involved in the post-war systems of administration will have to be approached from new angles." However, he clearly anticipates that this new order will continue to be within the framework of the Empire and hence his plea for basing future colonial administrative policy on the actual facts with regard to the society being administered. There is a bibliography of some 250 titles.

MARGARET MERRELL

ELEMENTARY STATISTICS.

By Hyman Levy and E. E. Preidel. The Ronald Press Company, New York. $2.25. vii + 184 pp. 1945.

In the introduction to this book, the authors give an excellent discussion of the difference between the numbers of real life and the pure numbers of the arithmetic book. In terms of concrete instances from every-day life they show that the "more or less" character of actual observation involves a different approach to numbers, and they make a good case for their statement that "no educated person can afford to dispense with a knowledge of statistics."

It is very disappointing to find that this orientation of statistics for the educated layman is not followed by a text of equal merit. The book presents chapters on the treatment of measurements of a single variable, and of two related variables; including a little on least square theory, on probability and error distributions, and finally on elements of quality control. For the most part the methods are presented around illustrative data, which is a very desirable approach in an elementary book. However, the illustrations are poorly selected, and in fact in a number of cases the methods are not applicable to the data chosen to illustrate them.

An extreme example of this is the case used as the main illustration of the calculation of the mean and standard deviation (pp. 23–34). A set of age-specific death rates from pulmonary tuberculosis is presented, and the problem is proposed to get the mean age of death and the standard deviation of the age of death from pulmonary tuberculosis from these figures. In the solution, the tabulation of the variable age is followed by a column headed "Death rates per 1000, i.e., Frequency of death," and the calculation treats these figures as if they were in fact frequencies of death. No interpretation can be given to the constants emerging from this treatment (the mean age of death presented is at least 10 years out of the way), since the methods used are entirely inappropriate to the data, and the data are entirely inappropriate for the solution of the problems posed.

In connection with this problem it should be noted that the data themselves are grossly in error. They are stated to be death rates per 1000 for London (1881–1900), and the values are in the neighborhood of 300 to 500 per 1000 for pulmonary tuberculosis alone. In addition, the tabulation starts at age 15, and the problem of getting the mean and standard deviation of age of death from tuberculosis when all children are omitted is decidedly artificial. This uncritical use of material, after an introduction to the subject of statistics which stresses the "false effect if the public generally are uncritical in their acceptance of the meaning of the statistics presented to them," seems especially unfortunate.

Other examples, although used less extensively, are equally inappropriate. Thus the frequency of occasions upon which specific numbers of soldiers are reported sick is used as an illustration of a continuous frequency distribution, although it is subsequently pointed out that it is really discontinuous (p. 11). The correlation coefficient is used to measure the degree of association, not merely as an intermediate computing constant, in variables that are not normally distributed (p. 82). The proportion of recruits wearing glasses and the proportion having false teeth are used for an example of the multiplication of independent probabilities (p. 102).

There are also certain interpretations of the statistical constants that need careful consideration. On pages 116 and 117 there is a demonstration concerning the value of the correlation coefficient according to the number of common causes in the two variables. However, the demonstration pertains only to the case in which the common causes enter the variables in an additive way, and the statements following this demonstration cannot be accepted as being general. On pages 120 and 159, the meaning of the probability associated with a significance test is misstated. On the latter page it says, "It follows that the chance of this happening by accident is 9 in 100 or the odds are 91 to 9 against it happening by chance." The significance test never measures the odds against its happening by chance. It measures the probability that chance would produce as large a deviation as this (9 in 100), and the probability that chance would produce a smaller deviation than this (91 in 100), but this

is quite different in meaning from the quoted statement.

Since the faults of the book, in careless acceptance of data and failure to see that the assumptions behind the theory are fulfilled by the data to which the theory is applied, are the greatest pitfalls for the beginner, the book cannot be recommended as an elementary text.

MARGARET MERRELL

WAHRSCHEINLICHKEITEN UND SCHWANKUNGEN.

Edited by F. Lubberger. (Julius Springer, Berlin); J. W. Edwards, Ann Arbor, Michigan. $3.00. 100 pp. (1937); 1944.

This book is a lithoprinting of a German publication, the reproduction being by the authority of the Alien Property Custodian. During the first part of 1936 a series of reports was prepared on "new developments in probability and variation," by the Union of German Electrical Technicians and the Extension Institute of the Technical High School in Berlin. These reports were revised and brought together in the present book.

The five essays are designed to educate the technicians in the part that probability plays in their field, and actually do not present new developments, but are introductory in character. The essays are by different authors and deal with (1) fundamental principles and laws of probability and variation (M. Czerny), (2) probability and quality control (K. Franz), (3) observations, rules, and theories of telephone service (F. Lubberger), (4) hidden periodic phenomena (J. Bartels), and (5) development of probability laws and variation phenomena in physics (R. Becker).

The purpose of the reports seems to be competently carried out, as they present a clear exposition of the elementary theory in the field with illustrative material. The justification for bringing out the present edition of the book is questionable, since the corresponding audience in this country, requiring an introduction to the application of probability theory to the technical fields in physics, will almost certainly turn to texts in English in which these topics are presented.

MARGARET MERRELL

BIOMETRICS BULLETIN, *Volume I, No. 1. February, 1945. Bimonthly.*

The Biometrics Section, American Statistical Association. $3.00 annually ($2.00 to Associate members; $1.00 to Members).

DE OMNIBUS REBUS ET QUIBUSDEM ALIIS

SCIENTIFIC SOCIETIES IN THE UNITED STATES.

By Ralph S. Bates. John Wiley and Sons, New York; Chapman and Hall, London. $3.50. vii + 246 pp. 1945.

This book is a significant contribution to the intellectual history of the United States. The part played by the scientific societies in this country's development has always been neglected by its historians, who, notwithstanding their emancipation from the time-honored theory that history should consist of lists of names of kings and battles, still tend to place the emphasis on the political phases of national evolution and to minimize the importance of its cultural aspects. The author has not attempted to tell the story of the development of scientific thought in the United States. That would be too long to be contained in a book the size of this one. But when that story is written, its compiler will find the work here under review to be an invaluable source of essential data.

The oldest scientific society in the country today is the American Philosophical Society, founded by Benjamin Franklin and John Bartram. Previous to its establishment there had been a brief efflorescence of scientific activity in Boston, inspired by Cotton Mather. Although short-lived, this abortive effort paved the way for others of a more permanent nature, such as the Connecticut Academy of Arts and Sciences, the oldest state institution in the country devoted to the pursuit of knowledge. But it was the example of the American Philosophical Society in Philadelphia that inspired the formation of similar societies in other cultural centers, such as Baltimore and Charleston.

It is interesting to note that those portions of the United States obtained by purchase or conquest from other foreign states had no scientific societies. Oregon was obtained from Great Britain, California from the Russian Empire and the Mexican Republic, Texas was an independent state, Louisiana came from France, and Florida from Spain; yet the first scientific institutions in these areas were the work of immigrants whose ancestors had helped to settle the thirteen colonies on the Atlantic seaboard. This does not mean that there had been no scientific exploration of the annexed territory, for there had been; it means only that the residents of these areas were not organizers. There is a good deal of epic truth in the statement that if two Englishmen were cast away on a desert island they would not speak to each other until they had been introduced, but that two Americans in the same circumstances would have formed a corporation within twenty-four hours. The extent to which not only all scientific, but all other activities in the United States are supervised by organizations—a matter which always astonishes visitors from Europe—is borne

witness to by the 211 organizations whose names begin with the word "American" listed in the 25-page index. (Incidentally, this list is not complete; the American Malacological Union has been omitted.)

The fact that the author's preoccupation has been with organizations rather than men is reflected in his choice of personalities to be emphasized. The three names that occur most frequently in the book are those of Louis Agassiz, Benjamin Franklin, and Benjamin Silliman—all of them born organizers, who had the ability to attract like-minded people and so became the nucleus of groups that carried on the work which they initiated. The two men whom the reviewer would consider our greatest scientific geniuses, David Rittenhouse and Edward Drinker Cope, are given only the scantiest mention, and some of our pathfinders in scientific research, such as James Logan in mathematics, David Zeisberger in anthropology and John Heckewelder in philology are ignored completely —as is also David Alter, the discoverer of spectrum analysis. The reason is clear; these men were rugged individualists. They organized no societies to perpetuate their memories, and their contribution to our national culture was purely personal. They were not the objects of the author's research, and the omission of their names is no reflection on his scholarship.

His omission of the New Harmony settlement is. Although this experiment failed to accomplish the social reformation for which it was planned, it did achieve an unforeseen success in making a contribution to the cultural life of the nation, of which it was for a short time the intellectual capital, and it certainly deserves mention in a book devoted to organized science.

In such a comprehensive work as this, it is inevitable that there should occur a few errors of commission. By the "College of Physicians" the author apparently has reference to the College of Physicians and Surgeons. The reader is not likely to gather from the statement that the Delaware County Institute of Science was active up to the Civil War and that its activity has also continued unimpaired since; and the statement that membership in the Delaware Valley Naturalists' Union is restricted to persons professionally engaged in scientific pursuits is quite inaccurate. Actually there are no such limitations on membership in this organization, which consists largely of amateurs; the present reviewer joined it in his undergraduate days.

From the above it will be realized that this work is not a continuous narrative. Neither is it a directory. It is a work of reference lying between these two extremes, valuable alike to the historian and to the student of the sciences, and those who wish to pursue the story of the scientific societies of the United States further than this book can take them will find the 28-page bibliography most helpful.

REPORTS ON SCIENTIFIC RESULTS OF THE UNITED STATES ANTARCTIC SERVICE EXPEDITION 1939–1941. *Proceedings of the American Philosophical Society, Volume 89, No. 1.*

The American Philosophical Society, Philadelphia. $4.00 (paper). vi + 398 pp. 1945.

Along with the geographical, geological, and meteorological reports of this expedition there are included in the present volume the biological reports, which are of considerable interest. Three papers deal with the aspects of human physiology involved in acclimatization: General Principles Governing Selection of Clothing for Cold Climates; Antarctic Trail Diet; and Acclimatization and the Effects of Cold on the Human Body as Observed at Little America III. Two general papers describe the biology carried on at East Base, Palmer Peninsula; and at Little America III. Then follow descriptive papers of the observed Foraminifera, Amphipoda, mollusks, an Octocoral, echinoderms, Collembola, mites, and miscellaneous invertebrates; fishes and birds. Descriptions of many of the birds and of the mammals are in the general papers. The illustrations are excellent.

SCIENCE TODAY AND TOMORROW. *Second Series.* *By Waldemar Kaempffert. The Viking Press, New York.* $2.75. v + 279 pp. 1945.

In this eminently readable book, the Science and Engineering Editor of *The New York Times* presents for the man with no background in science a vivid account of present discoveries and how they were made, and an exciting picture of what the future may hold. In the world of tomorrow he sees rocket travel to Venus, entire towns covered by great transparent plastic roofs, the cure of mental ills by brain surgery, super-penicillin, electronic robots for routine work, prefabricated houses, in fact "some houses may be nothing more than bubbles of glass." In such a world it is reassuring to find that at least alarm clocks remain.

Equally interesting and rather more important are the essays on that desperately urgent topic, the relationship between scientific discoveries and human living. These essays constitute a major portion of the book and range from a chapter on the relationship between war, science, and technology to a final one suggesting a method to achieve world unity through science. These chapters are thought-provoking, and it is to be hoped that they will have the audience they deserve.

It must also be honestly admitted that there are times, while reading the volume, when William Harvey's remark that Francis Bacon wrote science like a Lord Chancellor comes to mind. Anyone who has admired Kaempffert's distinguished science reporting

will feel a sense of disappointment that even such a generally competent individual can write, at least on biological topics, so like a man who has read it all in books, perhaps too many books. Not that the main ideas are often untrue. The thalamus is a primitive part of the brain. A worm is a primitive animal. But it does not follow that a worm has a thalamus! The human brain shows structural similarities with the brains of all other vertebrates, similarities based on evolutionary relationships, but the human brain does not bear the imprint of its evolution from the fish through the bird, dog, and horse up to man. The chapter on that hardy perennial, "Can the Laboratory Create Life?", begins by explaining that life is no longer regarded as a purely chemical affair, since it has been discovered that forces are at play within and outside of cells that enable them to adapt themselves to their environment. Whatever may be said for this statement, it is surprising to find, several pages later, Herbert Spencer's famous definition of life as an adjustment of internal to external relations held up to scorn as obsolete!

Such faults are a matter for regret but do not invalidate the interest or value of the book as a whole. Like the Lord Chancellor, Kaempffert is to be judged for his positive merits, and these are great indeed.

GAIRDNER MOMENT

SCIENCE IN PROGRESS. *Fourth Series.*

Edited by George A. Baitsell. Yale University Press, New Haven, Connecticut. $3.00. xvi + 331 pp. 1945.

In this most recent collection of lectures, the Society of Sigma Xi has adhered to the same high standards and desirable diversification of subjects as in former years. All the authors are leading investigators in their respective fields, two in fact being Nobel Prize winners. The lectures are addressed to the serious-minded reader who desires to know at first hand what is going on in science. There are places that will be tough going even for the well educated reader; but this Sigma Xi series is the closest possible modern equivalent of the popular works of Tyndall, Huxley, and Company of an age that is gone. Despite the war the book is well printed and well illustrated.

The lectures are: I, Psychological Aspects of Military Aviation, by W. R. Miles; II, The Physical Structure and Biological Action of Nerve Cells, by D. W. Bronk; III, Energy and Vision, by S. Hecht; IV, Chemical Transmission of Nerve Impulses, by O. Loewi; V, The Mathematical Nature of Physical Theories, by G. D. Birkhoff; VI, The Magnetic Approach to the Absolute Zero of Temperature, by P. Debye; VII, The Drift Toward Equilibrium, by H. Eyring; VIII, Streams of Atoms, by I. I. Rabi; IX, Adventures in Vacuum Chemistry, by K. C. D. Hickman; X, Present Status of the Vitamin B Complex, by C. A. Elvehjem; XI, Blood and Blood Derivatives, by E. J. Cohn. For each chapter there is a bibliography of from 15 to 60 titles.

GAIRDNER MOMENT

CAREERS IN SCIENCE.

By Philip Pollack, in collaboration with Evelyn Steele. E. P. Dutton and Co., New York. $2.75. 222 pp.; 32 plates. 1945.

Pollack, in his book *Careers in Science*, presents information primarily for the benefit of high school graduates interested in a scientific career. Being written in collaboration with "Vocation Guidance Research," it is necessarily written to act as an aid in determining one's eligibility for a scientific career. The necessity for this step is given special emphasis. The "price of admission," Pollack says, is high and includes patience, mental alertness, imagination, and a capacity for hard work.

The author describes the opportunities offered by each field. In physics such opportunities are centered on electronics, radio, television, and radar; in geology, with the discovery and development of oil deposits. Three chapters are devoted to biology—all of them good. Here the most stress, and justly so, is placed on the Public Health Services. This is particularly pertinent, now that government has so many far-reaching post-war plans for this agency.

This book has another excellent feature: woman's place in science. This being a new trend, the author has devoted a complete chapter to showing the increasing importance of this trend. The book continues with a short chapter entitled "Futurama." This depicts a Jules Vernesian world, but one well within the realm of possibility. Also there are two supplemental chapters, one on the excellent post-war future of physicists, the other on the need for inventors.

This book is of value in that it will fulfill the student's need for a guide to determine the character qualifications necessary in himself for a scientific career. The subject matter is presented in a logical and concise manner, easily understood by the layman. For this reason a high school student would find the book readable and helpful.

E. H. HERRON

MIKROPHOTOGRAPHIE.

By Gerhard Stade and Herbert Staude. (Akademische Verlagsgesellschaft M. B. H., Leipzig); J. W. Edwards, Ann Arbor, Michigan. $5.00. viii + 202 pp. (1939); 1945.

This book has undoubtedly lost a not inconsiderable amount of its quality and value through reprinting.

The depreciation is particularly apparent in the illustrations and is due in large measure to the lithoprint process, for which this type of book is not especially suited. Furthermore, many of the original drawings are of such poor quality that even in a better reprint good results would have been impossible to attain. As to the photomicrographs, of which there are fifty, the examples are not particularly arresting, and the poor reproduction of the negatives, or original glossy prints, leaves much to be desired. Many of the plates illustrating problems in geometrical optics are difficult to interpret because of the small size lettering and indistinct printing. Occasionally a magnifying glass is required to read the inferior and superior symbols, such as subscripts and primes. Many of the cuts depicting apparatus are of long standing and have been used frequently in earlier works. On the other hand, the book is surprisingly free from factual errors, although typographical errors do exist.

Chapter I is concerned with the formation of the microscope image. Among other subjects covered here are resolution, magnification, lens errors, objectives, and oculars. The use of Homal eyepieces is stressed.

The second chapter deals with equipment and accessories. Reference is made to the screw thread adopted universally for all objectives, although credit for this standard is not given to the Royal Microscopical Society by which it was developed in 1858. The mechanics of the microscope are described but not in great detail. Less emphasis is laid upon lamps and lighting technique than is to be expected in a book of this nature.

Chapter III also includes a description of apparatus and accessory equipment, but here attention is focussed on their use in various phases of photomicrography. Stereo-photomicrography, photomicrography with polarized light, the application of ultraviolet and infrared radiation are all mentioned. Contour measuring and projection systems are explained, as well as methods for the examination of surfaces, and cine-photomicrography is likewise discussed.

The fourth chapter covers the universal microscope cameras in addition to other types of cameras seldom seen in this country. All these camera variations are a study in themselves, for they represent the latest and most up-to-date photomicrographical equipment; unfortunately such instruments are not available at the present time.

Chapter V is devoted to the photomicrograph and to the technique of producing it. Various photographic dark-room formulae are listed. Reasons are offered for the use of optical filters for chromatic correction and for promoting photographic contrast. Sensitive material is discussed, as are light meters for determining exposure time. Also, the difficulty of using such meters is well explained. The authors appear to prefer glass plates to film, even in the smaller sizes. Attention is given to the importance of correct timing in order to avoid light scattering in the lower region of the emulsion layer of the plate. Also it is shown how such timing can be achieved by regulating the intensity of the illumination. On the whole this chapter, because of its expositions of seldom discussed detail, is, perhaps, one of the best in the book.

The latter part of the book, Chapter VI, carries an excellent bibliography, but naturally it is composed almost exclusively of references to German books or papers.

Mikrophotographie is a good reference for one who has a fair knowledge of geometrical optics and who wishes to learn about the microscope. It is not an elementary, easily-read book from which the beginner could expect to profit, except at the expenditure of a considerable amount of mental energy. The style is didactic, and explanations when offered are not always clear. Although practically all branches of photomicrography are touched upon, the reader is left with the necessity for consulting other authorities for more explicit working directions. Many of the important details which must be observed in order to make good photomicrographs are either not discussed in the book at all, or else are only mentioned in a cursory manner. Undoubtedly 202 pages are not sufficient to permit a clear exposition to be made of so complicated a subject as photomicrography, with its many ramifications. All in all, it seems as if the authors had in mind summarizing the different branches of photomicrography, and setting before their readers as many of the photomicrographic techniques as possible in as few words as possible; in this respect they have succeeded.

CHARLES P. SHILLABER

TALKING TO THE MOON.

By John Joseph Mathews. University of Chicago Press, Chicago. $3.00. viii + 244 pp. 1945.

After a varied career as aviator, writer, and businessman, J. J. Mathews built himself a little sandstone house in his native Osage country and lived there for ten years, more interested in coyotes, blackjacks, dogs, flowers, and birds, than in men. In twelve chapters, named after the old Osage moons, the author tells about this life close to nature and the thoughts it inspired. Though not a scientific book, this is one many scientists and naturalists might enjoy.

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